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## A Preliminary Report on the Venom Apparatus of the Bat-ray, *Holorhinus californicus*

By BRUCE W. HALSTEAD and F. RENE MODGLIN

DESPITE the frequency of stingray attacks in the United States, little is known regarding the so-called "venom apparatus" of endemic batoidian species. Surprisingly enough, the bulk of the literature dealing with the microscopic anatomy of the stings of these fishes is based chiefly on the original work of two investigators, Antonio Porta (1905) and H. Muir Evans (1916, 1921, 1923, 1924, 1943). Unfortunately, their histological investigations concerning stingrays were limited principally to two European species, *Dasyatis pastinaca* (Linnaeus) and *D. violacea* (Bonaparte).<sup>1</sup> Evans (1923: 7, 8) demonstrated that Porta (1905) had been mistaken in his observations regarding the distribution of the glandular tissue in the sting. Daniel (1934: 28, 35, 36) briefly referred to some work on the sting of *Urobatis* (for which he used the name *Urolophus*) and stated that it is doubtful that the secretion of the mucous cells associated with the sting is any more toxic than the acrid mucus of other glands. Attempts to find a more detailed report of this work have failed. The controversial remarks of such men as Bottard, Boulenger, Lankester, Pawlowsky, and Jordan concerning the presence of a true venom organ in stingrays convince one that the entire subject is in need of much more study.

For a more detailed discussion of the historical aspects of the venom organs of stingrays, the reader's attention is directed to the excellent summaries of Evans (1916: 431-432; 1923: 1-3) and Gudger (1943: 467-503).

We are engaged in a study of the stingrays found in the waters of California; namely the two families, Dasyatidae, the stingrays proper, and Myliobatidae, the eagle rays. There are 3 species of dasyatids native to California; they are: *Dasyatis dipterura* (Jordan and Gilbert), the diamond stingray; *Urobatis halleri* (Cooper), the round stingray; and *Gymnura marmorata* (Cooper), the California butterfly ray. The Californian Myliobatidae are represented by a single species, *Holorhinus californicus* (Gill), the bat-ray (Fig. 1). This particular report has been limited to a detailed discussion of the sting apparatus of *H. californicus*.

### GENERAL DISTRIBUTION AND HABITS OF *Holorhinus californicus*

*Holorhinus californicus* is a common inhabitant of shallow bays, sloughs, and mud flats from Cape Mendocino, California, to Santa Maria Bay, west coast of Lower California. Since shellfish make up the principal portion of the diet of this fish it is generally considered to be a pest of economic significance. When dormant, *H. californicus* displays the habit typical of most rays and is found resting on or in the upper layers of the mud. Where stingrays are likely to occur it is advisable to shuffle one's feet through the mud as a precautionary measure against stepping on a ray.

The material described in this report was obtained from the shrimp

<sup>1</sup> Both of these species were allocated to the genus *Trygon* in the works cited. The validity of the second one has been questioned by both Lozano Ray (1928: 631) and Garman (1913: 390).

trawlers of the Hunter's Point Shrimp Company, of San Francisco, California. The fish were caught in shrimp nets approximately one mile south of Yerba Buena Island, San Francisco Bay, in about 60 feet of water.

#### MEDICAL SIGNIFICANCE OF MYLIOBATID RAYS

The literature reveals very few verified accounts of attacks from myliobatid rays, even though they are generally recognized to be dangerous to man. Whitley (1940: 197-199) and Schultz (1944) have discussed stingray attacks quite at length, but neither specifically mentions any member of the Myliobatidae. Gudger (1914: 299; 1943: 482) has probably listed most of the acceptable published accounts in his two papers regarding this subject. However, the species under discussion in each paper was *Aetobatus narinari* (Euphrasen). No written reports regarding attacks from *Holorhinus californicus* have been found to date. Shrimp fishermen volunteer the information that they are occasionally stung by this ray when attempting to remove them from their nets. This fact and the instances noted below show that a greater number of attacks from *H. californicus* have occurred than is indicated by the total lack of published records. Gudger (1914: 298) has suggested that possibly the paucity of attacks from myliobatid rays is due to the docile habits of the group and the proximal location of the sting on the tail. On the other hand, Daniel (1934: 37) reasons that the proximal location of the sting gives the ray more accuracy and greater striking force than is displayed by its relatives.

#### CLINICAL CHARACTERISTICS

One of the most frequent sites of stingray wounds is in the region of the ankle. Contact with the ray is made by stepping on the body of the fish. This gives the animal the anchorage and leverage needed to drive the sting into the flesh of the victim.

The authors are indebted to Dr. Carl L. Hubbs and Mr. Herbert J. Mann (*in litt.*), of the Scripps Institution of Oceanography, La Jolla, California, for the following case history regarding an attack by *Holorhinus californicus*.

During one of the late summer months several years ago, Mr. Mann was swimming and spear fishing near the reef just north of the Scripps Institution. He stepped on a bat-ray and received a deep wound on the plantar surface of his right foot. The ray was a fairly large specimen, having an estimated fin spread of about 4 feet. By the time he reached shore, about twenty minutes later, the pain had become intense. Within a short time he was unable to walk on the injured member because of the severity of the pain and was forced to crawl on his hands and knees. Soon after leaving the water his foot became greatly swollen and cyanotic. The pain was said to have been pulsating in character. There was no nausea, vomiting, faintness, paralysis, paresthesia, nor any other noticeable neurological disturbance. Mr. Mann was unable to determine exactly how much bleeding had occurred during the time that he had been in the water, but there was very little subsequent loss of blood. Approximately one-half hour after the attack Mr. Mann treated the wound with potassium permanganate. This

treatment had little effect in reducing the intensity of the pain. The pain continued for about two days. Gradually the pain and swelling subsided. Healing was uneventful. The victim still bears a scar from his encounter with this fish.

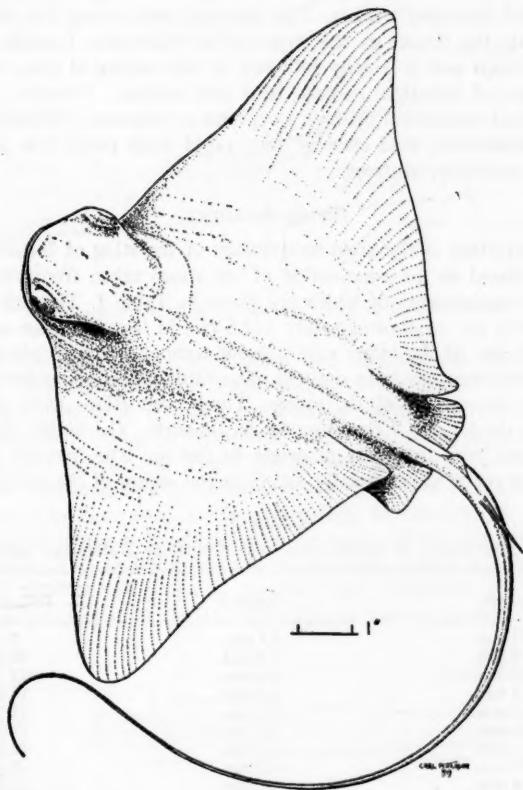


Fig. 1. *Holorhinus californicus* (Gill)

Mr. G. E. MacGinitie, Director of the Kerckhoff Marine Laboratory of the California Institute of Technology, has very kindly supplied us with the following interesting account of being stung by a fetal bat-ray. In June, 1930, he caught a large female *Holorhinus californicus* in Elkhorn Slough, California. The ray was incised and found to be pregnant. During the process of extracting one of the fetuses, Mr. MacGinitie was stung on the left thumb. The pain was instantaneous, intense, and throbbing in character. The pain continued for about one hour and then gradually subsided. A moderate amount of swelling occurred and there could be seen

an ischemic zone around the wound. There were no other symptoms or complications and healing was uneventful.

Injuries from stingrays are usually of the puncture-wound variety. The severity of the pain is greater than is commensurate with just a mechanical laceration. Removal of the sting is accomplished only with a great deal of effort and increased trauma. The recurved teeth along the sides of the sting lacerate the tissues as the structure is withdrawn. Localized swelling rapidly develops and is usually followed, in the untreated case, by the additional signs of infection, namely, heat and redness. Primary shock may be present and manifested by such symptoms as faintness, weakness, nausea, loss of consciousness, cold clammy skin, rapid weak pulse, low blood pressure, and respiratory distress.

#### GROSS ANATOMY

Our description of the gross morphology of the sting of *Holorhinus californicus* is based on an examination of ten stings taken from young specimens, the measurements of which are given in Table I. The fish varied in size from 49.6 cm. to approximately 122.0 cm. in length. Since our records of the exact size of the larger rays are not complete, a correlative study of sting and fish sizes has been omitted. The table reveals considerable variation in the proportions of the stings. These proportions were determined by dividing the length of the sting by its breadth. The length of the sting was measured from the point of origin to the tip. The breadth was taken at the widest point which usually occurs in the region of the proximal third.

TABLE I  
SIZE AND PROPORTION OF STINGS FROM THE YOUNG OF *Holorhinus californicus*

Length	Breadth	Proportion
40.3 mm.	5.7 mm.	7.1
41.0 mm.	4.0 mm.	10.3
50.0 mm.	4.0 mm.	12.5
50.3 mm.	3.5 mm.	14.4
52.5 mm.	3.0 mm.	17.5
53.6 mm.	4.4 mm.	12.2
67.1 mm.	4.2 mm.	16.0
68.0 mm.	4.5 mm.	15.1
75.4 mm.	6.1 mm.	12.3
77.0 mm.	6.0 mm.	12.8

The entire sting is originally enclosed within a sheath of slime-covered skin (Fig. 2). As the young sting grows out from the tail, it takes with it a layer of the integument which continues to envelope the adult structure until it is removed by either trauma or wear. The external surface of the sheath is similar in appearance to the rest of the caudal skin, dark gray and scrobiculate. The ventral surface of the integumentary sheath is free from the dorsum of the tail everywhere except at the point of origin.

The sting is generally considered to be a strongly modified or hypertrophied placoid scale (Daniel 1934: 30, 35), which is derived principally from mesoderm. It arises from the dorsal surface of the caudal appendage,

almost immediately behind the single dorsal fin. The distance between the vertical of the origin of the sting and the center of the vent is approximately  $3\frac{1}{2}$  in the distance between the center of the vent and the tip of the snout. This proportion is subject to considerable variation as a result of the displacement which occurs in the process of sting replacement.

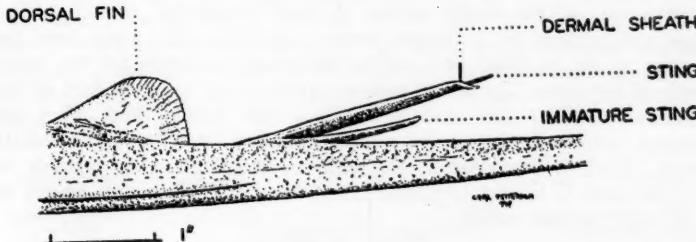


Fig. 2. Lateral view of tail showing sting of *H. californicus*

The base of the sting arises from a thin cartilaginous matrix which is intimately associated with the neural spines of the caudal vertebrae. The skin on the dorsum of the tail, immediately beneath the sting, forms a shallow, elongate, V-shaped depression which receives roughly one-half to two-thirds of the proximal length of the mature sting. For the sake of convenience this area will be designated the cuneiform area (Fig. 3). The skin of the cuneiform area is soft and spongy in consistency, which is in contrast to the adjacent hard caudal integument. This is the area to which Daniel (1934: 28), in his discussion of *Urobatis*, refers as being provided with great numbers of goblet or mucous cells. However, he is skeptical of the toxic properties of the secretion by the mucous glands in this area.

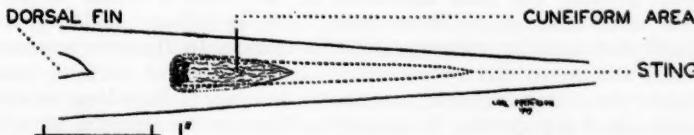


Fig. 3. Dorsal view of tail (sting removed) of *H. californicus*

Separation of the sting and adjacent integument reveals that the base of the sting is connected to the caudal musculature by collagenous connective tissue. These tendons are probably used in connection with the erection of the sting.

The mature sting is an elongate, tapering calcified structure, ivory to white in color, bilaterally serrate with a variable number of sharp, recurved teeth, and terminates with an acute sagittate tip. The dorsal surface is marked by a number of irregular grooves which are most pronounced at the base, becoming indistinct as they approach the distal third of the sting.

and finally obliterated near its tip (Fig. 4). Occasionally a very much enlarged, deep median groove is present which arises at the base and extends up the sting for a variable distance. The remainder of the sting is smooth and without grooves. In the distal and middle thirds the sting is transversely rounded. It is flattened in the proximal third. The basal third of the ventral surface of the sting is even more flattened than the corresponding area of the dorsal surface. A very pronounced ventral median ridge, accompanied by a distinct groove on either side, arises near the junction of the proximal and middle thirds and continues for the entire length of the sting. The lateral grooves originate in the basal third of the structure and have their greatest depth in the middle third. They are bounded medially by the ventral median ridge and laterally by the dentate margin, which is composed of the recurved teeth. Since the number of marginal teeth is subject to considerable variation, tooth counts appear to be of little practical value.

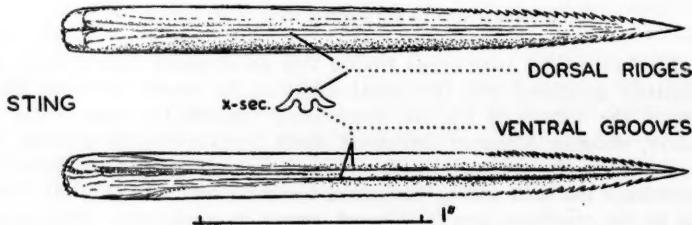


Fig. 4. Dorsal (in upper) and ventral (in lower) views of sting of *H. californicus*

All of the stings examined in this study revealed a strip of soft, spongy, grayish, sparsely pigmented tissue laying along the entire length of the ventral grooves. The gross appearance of this tissue is similar to that of the tissue described by Porta (1905: 235) and Evans (1923: 4) in *Dasyatis* and called by them the glandular triangle. In *Dasyatis*, however, Evans (*ibid.*) found that a black line of pigment separated the teeth from the glandular triangle. Gross examination of the stings of *Holorhinus* reveals no such line of demarcation. It is clearly evident that the glandular triangle is a remnant of the former integumentary sheath of the sting. The tissue in these grooves in the unworn sting is continuous with the tissue between the marginal teeth and the covering of the rest of the sting. The integumentary sheath is gradually worn away over a period of time so that the only tissue that remains is lying in the protection of the grooves. The nature of this tissue becomes evident only upon microscopic examination.

There is no evidence to support the idea that the stings of these rays are shed each year. Specimens of *Holorhinus californicus* of various ages have been examined bearing one to three stings at various stages of growth. Apparently the stings remain until they are traumatically removed or have served their period of usefulness, and it is very doubtful that the latter is on an annual basis.

## MICROSCOPIC ANATOMY

*Caudal Appendage.*—The following description of the microscopic anatomy of the caudal appendage is based on an examination of serial cross sections covering the area between the insertion of the caudal and the vertical of the posterior third of the sting.

Sections of the caudal appendage immediately distal to the base of the sting clearly demonstrate a division of the appendage into three rather distinct zones: a peripheral integumentary layer, an intermediate muscular zone, and a central cartilaginous endoskeleton. Numerous vascular, nervous, and glandular structures are associated with the muscular and endoskeletal zones (Fig. 5).

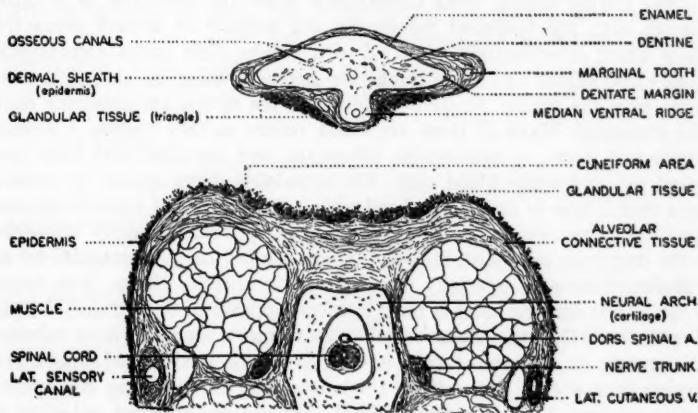


Fig. 5. Cross sections of sting (upper) and tail (lower) of *H. californicus*  
A. = artery; V. = vein

The epidermis is stratified and, in general, is the thickest on the dorsal surface, becoming thinner progressively around the caudal appendage to the ventral surface. The epidermis is most easily described when considered as consisting of three layers: a superficial, an intermediate, and a basal layer. The basal layer, consisting of a single layer of tall columnar cells, rests on a distinct, homogeneous, pink-staining, acellular basement membrane. The nuclei are large, light blue, and easily occupy one-half of the cell volume. The superficial layer is of two to five cells in thickness with a marked tendency of the cells to be flattened and not distinctly laminated. The nuclei stain darkly and the nuclear volume appears to be greater than that of the cytoplasm. The intermediate layer varies from three to ten cells in thickness with the cells irregularly stratified and becoming more flattened in the plane of the surface as they approach the superficial layers. Scattered throughout the epidermis are numerous secretory vacuoles, some of which occur singly while others are arranged in definite clusters. These secretory vacuoles are seen in greatest abundance on the dorsal surfaces with the maximum concentration noted in the cuneiform area. The dermis of this

same area is thrown up into several laminae which project far into the overlying epidermis dividing it into three to five definite acini. A similar acinous formation is noted to a lesser extent on the lateral surfaces. Penetrating from the epidermal surface into, but not completely through the epidermis, are occasional clefts which are not unlike those produced by the sweat glands in man. Moreover, the remaining epidermal cells are seen in many stages of secretory activity and occasional vacuoles are seen with their peripherally placed, flattened, dark nuclei. Pigment, ranging from yellowish brown to black in color, and granular to solid in appearance, is scattered through the epidermis in stellate or oval-shaped cells. The greatest amount of pigment occurs in the thicker portions of the epidermis.

The thicker dermis, lying immediately below the epidermis, is in direct contact with the basement membrane and consists of fibrous connective tissue which is moderately sprinkled with slender dark nuclei. Occasionally small blood vessels and nerve trunks are seen separating the basement membrane from the dermis. Scattered throughout the dermis are numerous duct-like structures. Many of these are blood vessels as they possess a definite intima and media, a questionable adventitia, and are filled with both nucleated red and white blood cells. The remaining ducts appear as nothing more than a hole in the dermis lined with a single layer of cuboidal epithelium. Along the horizontal axis of the caudal appendage, deeply embedded in the dermis on each side, is seen a lateral sensory canal surrounded by an oval-shaped mass of especially dense, fibrous connective tissue. The lumen of the lateral sensory canal is lined by what appears to be a stratified layer of epithelium. However, closer examination reveals a simple layer of cuboidal cells resting on a layer of cells having basophilic oval-shaped nuclei and varying from one to four cells in thickness with, seemingly, no consistency in arrangement. The cells in the medial wall area are enlarged, spherical to flattened, layered, and seem to serve as a supporting structure for a single layer of tall columnar cells. Serial sections through the longitudinal axis of the caudal appendage indicate that these tall columnar cells are arranged in hillocks. These hillocks of neuro-epithelium agree quite well with Daniel's (1934: 278) description of the neuromasts found in the lateral sensory canal of *Triakis semifasciata* Girard. A small ganglion is frequently seen lying medial to this sensory organ and is separated from it by a thin strand of the fibrous connective tissue which encapsulates the sensory canal. The lateral cutaneous veins are located, one on each side, just medial to the lateral sensory canals. Pigment masses are found distributed throughout the more superficial portions of the dermis.

The muscular zone is by far the largest division, occupying over one-half the diameter of the appendage. It is divided into three definite fasciculi on either side by septa of fibrous connective tissue. This division is to be observed in all of the serial sections that have been made in the region of the sting to date. These septa extend in from the dermis to, and around, the endoskeleton. The large muscle fibers are seen cut in transverse, oblique, and longitudinal planes in any one section. Their peripherally placed nuclei vary from slender to dot-like, depending on the plane of sectioning. Each muscle fiber is separated from its neighbor by a continuous

network of thin connective tissue fibers. The nerve trunks are intrafascicular and are consistently seen with the largest trunks medially placed. A ganglion is frequently seen on either side along the medial aspect of the intermediate fasciculus, surrounded completely by a shell of fibrous connective tissue.

The vertebrae have the appearance of embryonic hyaline cartilage showing many peripherally placed calcification centers. Each vertebra is divided into three regions: a dorsal inverted U-shaped neural arch, a ventral V-shaped haemal arch, and an intermediate circular centrum. The surfaces of these structures are covered by a thin layer of fibrous connective tissue except for the centrum, a biconcave disk, the anterior and posterior faces of which are deficient in this respect. The cartilaginous matrix of the centrum is packed with chondrocytes and in several places the appearance is highly suggestive of fibrocartilage. Within the neural canal is the spinal cord with its accompanying blood vessels. The haemal arch contains the ventral aorta and caudal vein which are surrounded by appreciable amounts of areolar connective tissue.

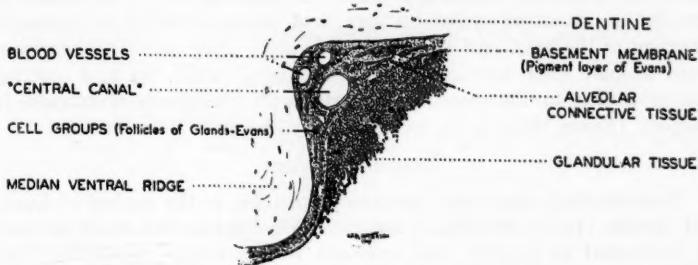


Fig. 6. Cross section of sting showing enlarged view of glandular triangle of *H. californicus*

**Sting and Integumentary Sheath.**—The external configuration of the sting in cross section is roughly diamond-shaped and consists of a broad T-shaped dentinal structure completely encompassed by a layer of integument (Figs. 5, 6). Cross sections of the marginal teeth are frequently seen in the lateral aspect of each horizontal limb of the dentinal structure and are attached to, or separated from, the latter, depending on the cut of the section. The integumentary sheaths in our specimens are notably devoid of epidermis except on the ventral surface. The vertical limb of the sting in cross section is called the median ridge and the outermost portion of each horizontal limb is termed the dentate margin. The tissue lying in the ventral groove, bordered by the median ridge and the dentate margin, occupies the area that has been designated (Evans 1923: 4) as the glandular triangle. In *Holorhinus californicus* this area is more rectangular in shape than in *Dasyatis pastinaca* and does not have quite the sagittate appearance that it does in the latter species. The dentinal structure, at every point along its surface, is separated from the overlying dermis by a thin layer of enamel.

The remainder of the sting is dentine. Scattered throughout the dentine are a variable number of canals, the osseous canals, which are occupied by areolar connective tissue and small blood vessels.

The glandular triangle is divided into two parts by the basement membrane of the integumentary sheath of the sting. This innermost portion, the area bordered by the median ridge and the dentate margin, is occupied by modified integumentary connective tissue. Interspersed throughout the connective tissue are a variable number of ducts, only two of which are consistently present. Microscopic examination of these ducts reveals them to be characteristic blood vessels filled with both nucleated red and white blood cells. Also scattered throughout the connective tissue are numerous strands of elongated cells with plump spindle-shaped nuclei and spherical cells with eccentrically placed dark nuclei. Both types of cells are occasionally seen grouped together in small clusters. The outer portion of the glandular triangle is composed of epithelial tissue. Resting directly on the basement membranes are thick sections of irregularly stratified epithelium. These cells are morphologically similar and identical in arrangement to those described in the caudal appendage. Secretory activity, as evidenced by vacuolation, increased cytoplasm area, and phantom nuclei, is markedly increased in the basal half of the sting; however some secretory activity is noted in more distal sections. The "lateral flaps," which act as a covering and protection to the more distal portions of the glandular triangle in *Dasyatis* (Evans 1923: 6, 7), are apparently absent in *Holorhinus*.

#### TECHNIQUES USED

Formalin-fixed stings were decalcified according to the method of Evans and Krajan (1930), dehydrated and cleared in ethyl alcohol and cedarwood oil, embedded in paraffin, and sectioned with a rotary microtome. The sections were stained with hematoxylin and triosin. Considerable difficulty was experienced, and never completely conquered, in preventing shattering of the sections while cutting. Various softening procedures were employed with minor degrees of success. Recently we have given attention to the celloidin method of preparing these brittle sections and progress thus far has given us renewed hope for the better preparation of this material.

#### SUMMARY AND CONCLUSIONS

1. A detailed description is given of the gross and microscopic anatomy of the sting and adjacent caudal area of *Holorhinus californicus* (Gill).
2. A strip of soft grayish tissue can be seen macroscopically lining each of the ventral grooves. Histological studies reveal that the outer portion of this tissue is glandular epithelium.
3. Microscopic examination of the cross section of the caudal appendage just below the proximal half of the sting reveals that there is a heavy concentration of the glandular epithelium which is not seen elsewhere on the tail. This area has been designated the cuneiform area and it is our opinion that this area is an integral part of the venom apparatus of the sting.
4. The sting apparatus of *Holorhinus californicus* is quite similar to that of *Dasyatis (Trygon) pastinaca* as described by H. Muir Evans.

5. The case histories given in this report, and the clinical histories of others support the idea that the sting is a venom organ.

6. This is a preliminary report and is to be followed by additional anatomical and toxicological studies.

#### ACKNOWLEDGEMENT

We wish to express our appreciation to the Hunters' Point Shrimp Company for their many kindnesses. Thanks also go to Mr. Henry Kuhn for his aid in the procurement of material; to Mr. Carl Peterson, for the illustrations; and to Doctors Carl L. Hubbs, W. I. Follett and Rolf Bolin for their helpful suggestions and criticisms.

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SCHOOL OF TROPICAL AND PREVENTIVE MEDICINE, LOMA LINDA, CALIFORNIA.

## The Fecundity of Some Herring from Seal Rock, Washington<sup>1</sup>

By MAX KATZ and DONALD W. ERICKSON

THE rational management of a fishery should, among other things, call for a detailed knowledge of the fecundity of the species exploited. Information on the relative fecundity of fish of different sizes and of various ages has more than academic importance. Knowledge of the fecundity of commercial and game species has become of practical importance in view of the trend of fisheries management toward intrusting the recruitment of new stocks to the fish in their normal habitat.

A survey of the available literature dealing with the fecundity of various fishes reveals that most authors merely indicate that small fish produce many thousands of eggs and larger fish produce many more thousands. Few of these studies yield information of value in a management program. For example, one would like to know just what is the relationship of length and age to fecundity.

As a part of an investigation of the herring, *Clupea pallasii* Cuvier and Valenciennes, a collection of 53 gravid female herring was taken at the spawning areas at Seal Rock, Washington, in the spring of 1936 (Chapman, Katz, and Erickson, 1941). Although it soon became apparent that this number afforded insufficient data for a thorough elucidation of the problem, it was felt that enough information of significance was gathered so that some conclusions could be drawn.

### PROCEDURE

The 53 female herring used in this study ranged from 139 to 220 mm. standard length, and their ages, as determined on 48 fish from their scales, varied from 2 to 8 years. In this work, a two-year-old fish was one that was just starting its third season of growth. The second annulus was in the process of formation at the periphery of the scale. Most of the fish were from 2 to 4 years of age, with only a few in the 5- to 8-year age classes.

These herring had been collected before any spawning had taken place. The eggs were removed from the ovarian tissue and were dried over a steam radiator until no further loss of weight could be detected with an analytical balance. The dried ova were weighed to the closest milligram. Then a sub-sample of about a gram was weighed accurately and the number of ova in this sub-sample was counted. Knowing the weight of the total sample, the weight of the sub-sample, and the number of ova in the sub-sample, the total number of eggs in the ovaries of each fish was calculated by direct proportion.

### THE RELATIONSHIP OF FECUNDITY TO LENGTH

The numbers of ova ranged from a minimum of 6,307 in a fish of 144 mm. in length and 2 years of age, to 40,918 in a specimen 220 mm. long and 7 years old. The smallest fish in the collection, 139 mm., however, had 8,005 eggs. The oldest fish, an 8-year-old of 208 mm., had 39,814 eggs.

<sup>1</sup> This study was made while the authors were with the Washington State Department of Fisheries, Seattle.

As expected, the number of ova increased as the standard length of the fish increased (Table I and Fig. 1). In order to study the relative increase in fecundity with length, herring of the 139 to 145 mm. size group, which were the smallest in the collection, were chosen as the basis for comparison. The mean egg production of this group, 7,101 ova, was designated as unity, and the mean egg productions of the other herring, which were grouped into 5 mm. size classes, were compared with this group of small fish. For convenience, the two largest fish of the collection were placed in a single class.

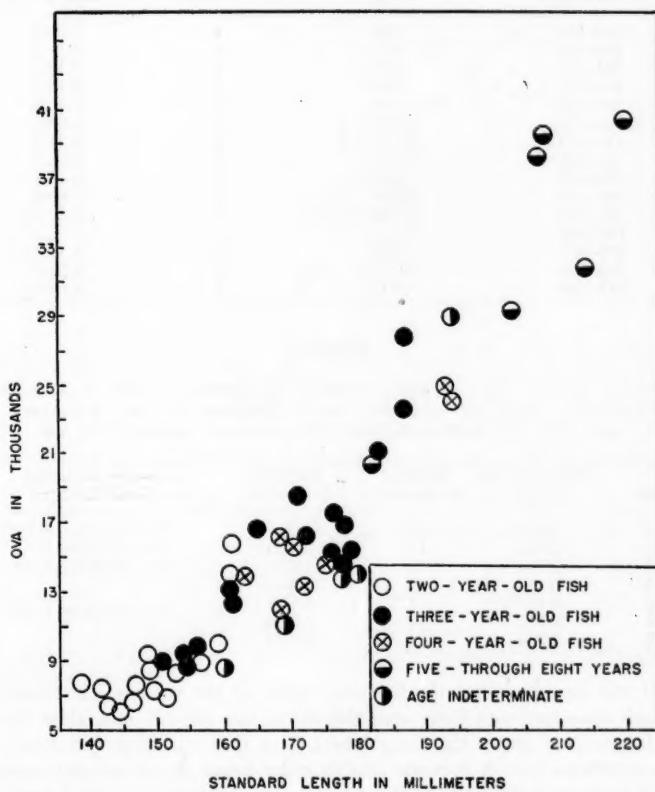


Fig. 1. The relationship of age and length to fecundity of Seal Rock herring.

The ratios of the mean egg production of the various size classes of fish as compared to the unit class (Table I) show a rapid increase with each relatively small increase in standard length. It is at once evident that the increase in the number of ova per unit of increase in length is far more rapid than an arithmetical progression. The 211-220 mm. herring, for exam-

ple, are only 50 per cent longer than the fish of the unit-size class, but they produce more than five times as many eggs.

TABLE I

EGG COUNTS ON SEAL ROCK HERRING, AVERAGED BY LENGTH GROUPS OF THE FISH, PLUS FECUNDITY RATIOS FOR THE LENGTH GROUPS COMPARED TO THE COUNT (AV. 7,101) FOR THE 139-145 MM. CLASS

Standard length in millimeters	Mean number of eggs	Number of fish	Ratio to basic group
139-145	7101	4	1.00:1
146-150	8273	6	1.16:1
151-155	8288	5	1.16:1
156-160	9229	5	1.29:1
161-165	13941	6	1.96:1
166-170	12952	3	1.83:1
171-175	15915	4	2.24:1
176-180	15532	8	2.18:1
181-185	21007	2	2.95:1
186-190	26203	2	3.69:1
191-195	26262	3	3.69:1
196-200	...	...	...
201-205	29641	1	4.17:1
206-210	39325	2	5.53:1
211-220	36538	2	5.14:1

TABLE II

FECUNDITY OF SEAL ROCK HERRING, AVERAGED ACCORDING TO AGE OF FISH, WITH FECUNDITY RATIO OF EACH AGE GROUP COMPARED TO THE TWO-YEAR-OLDS, AND WITH LENGTH-FECUNDITY RELATIONSHIPS ACCORDING TO AGE

Age	Average number of eggs	Number of herring	Ratio to 2 yr.-olds	Length-fecundity relationship
2	8608	17	1.00:1	$F = .0000236 L^{3.46}$
3	15815	17	1.84:1	$F = .0000310 L^{3.89}$
4	16842	8	1.95:1	$F = .0000328 L^{3.87}$
5	26414	2	3.06:1	
6	38376	1	4.46:1	
7	35279	2	4.09:1	
8	39914	1	4.63:1	$F = .0002340 L^{3.52}$

It will be noted that the fecundity ratio of the various size classes to the unit class increases fairly smoothly up to the 206-210 mm. class, but in the largest size group the ratio 5.14:1 is a decrease from the 5.53:1 of the preceding class. A decrease of this order based on an adequate sample would indicate a decrease in the rate of egg production in the larger and older fish, but our sample is small and may not be entirely reliable on this point.

#### THE RELATIONSHIP OF FECUNDITY TO AGE

The increase in fecundity of the herring with age is also pronounced. The fish with the single annulus, i.e., the 2-year-olds, are upon the spawning grounds for the first time and are used for the sake of comparison as the unit

class. The ratio of the fecundity of the older herring to the 2-year-olds (Table II) indicates that the 3- and 4-year-old fish produce almost twice as many eggs as do the 2-year-olds; the 5-year-olds about three times as many eggs; the 6-, 7-, and 8-year-olds over four times as many eggs.

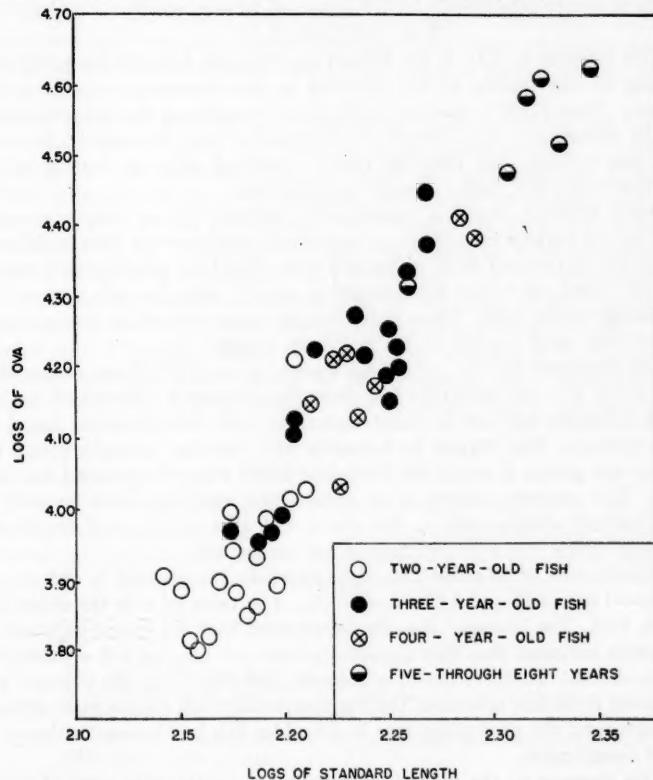


Fig. 2. The relationship of age and length to fecundity of Seal Rock herring, expressed logarithmically.

#### DISCUSSION

It has been shown that, in general, the ova production of the herring of Seal Rock, Washington, increases with the length and with the age of the fish. It is noted, however, that the relationship of length to fecundity is not a simple one, for when the calculated numbers of ova are plotted against the standard lengths of the fish (Fig. 1) the curve is parabolic. When the logarithm of the number of eggs is plotted against the logarithm of the standard length of the fish, a straight line is obtained (Fig. 2) which indicates a length-fecundity ratio fitting the general formula  $F = C L^n$ . In this equation,  $F$  is the fecundity,  $C$  is a constant to be determined for the herring of the collection,  $L$  is the standard length of the fish in millimeters, and  $n$  is

the calculated exponent describing the rate of increase in fecundity per increase in unit length.

A straight line was fitted to the logarithms of the standard length and the fecundity by the method of least squares, and the expression for the length-fecundity relationship of this group of herring was found to be:

$$F = .00000436 L^{4.71}$$

This value of  $n$ , 4.71, is the highest exponent for a length-fecundity relationship of any species of fish recorded in the literature available to the authors. Riatt (1935), who had studied the fecundity of the haddock, found  $n$  to be greater than 3.0. Farran (1938) found a value for  $n$  of 4.5 for some Irish Sea herring; and Hickling (1945), working with the herring of the southern North Sea, found a value for  $n$  of 3.465.

Riatt, however, found a considerable variation in the length-fecundity ratio for the various age classes in his haddock, and the data for the different age groups in the Seal Rock collections were, therefore, analyzed in a similar manner. Each year class was treated separately with the exception of the 5- through 8-year-olds. These older herring were grouped as one class because of the small number of fish in the age groups.

The exponents for the various age classes, none of which are greater than 3.9 (Table II), are markedly less than that exponent determined for the entire collection and are in closer agreement with the exponents found by other workers. The increase in fecundity with increase in length within the various age groups is much less than that found when the grouped data are used. This suggests, among other things, that caution should be used in mathematical studies such as the above and that careful analyses should be made before any final conclusions are announced.

Nevertheless, it is noted that the exponents are greatest in the 3- and 4-year-old fish, 3.89 and 3.87 respectively. The value of  $n$  in the oldest fish is less, 3.52. The youngest fish, the 2-year-olds, have the lowest exponent of all, which indicates that they apparently have not reached full efficiency as egg producers. These values of  $n$  indicate, therefore, that the younger fish are rather inefficient spawners, the vigorous mature fish are the most efficient spawners, and the production rate in the older fish has lessened although it is still considerable.

This decrease in the rate of egg production in the older age classes of herring agrees with the findings of Riatt (1935) that there was a decrease in egg-producing efficiency in haddock after they had passed a certain age. It was found that older haddock produced fewer eggs than younger haddock of the same size, and Riatt suggested that the decrease in egg production be regarded as a criterion of old age in fish. Fujita and Kokubo (1927) found that their oldest specimen of herring, a 9-year-old, produced only 25,280 eggs, while the 8-year-olds averaged 52,246 ova. Although the data of our Seal Rock herring do not reveal so striking changes with the advent of senility as indicated above, there is an apparent decrease in the rate of increase of egg production as the fish grows older. Hatchery men have recognized this phenomenon in trout. John Johansen, of the Washington State Department of Game, pointed out that old, brood-stock trout were usually poor egg producers and that they were discarded in favor of younger fish.

Although the rate of increase in fecundity decreases as the fish grow old, it can be seen in Figure 2 that the older herring generally produce more eggs than younger herring of the same size. Of course, there are exceptions. For example, a herring of 172 mm., 3 years old, produced 16,305 ova, a 4-year-old herring of the same length, only 13,526 eggs. The authors feel that among herring of the same length, the older fish produce more eggs than the younger, but as the fish become senile the increase in the ova production will become less.

Although the above conclusions may prove to be of interest and value in the formulation of policy in a herring conservation program, a word of caution should be appended. The data found here apply only to the sample of herring from Seal Rock, Washington, and should be applied with great caution to other herring populations. For although the increase of fecundity with increasing age and greater length was found to hold true in other Pacific herring races (Ambroz, 1931; Fujita and Kokubo, 1927), there is a substantial and consistent difference in the fecundity of the herring discussed in this work and those from other parts of the Pacific (Katz, 1948). The various geographical races of herring differ not only in the number of vertebrae, but also in the number of ova produced, and a separate study should be made on each population if an extremely critical program is undertaken.

#### ACKNOWLEDGMENTS

The authors wish to acknowledge the contributions of Dr. W. M. Chapman, M. B. Schaefer, and the late R. T. Smith, whose efforts are responsible for much of value in this paper. Frank Lowman, of the Applied Fisheries Laboratory of the University of Washington, drew the figures.

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SCHOOL OF FISHERIES, UNIVERSITY OF WASHINGTON, SEATTLE, 5, WASHINGTON, and U. S. FISH AND WILDLIFE SERVICE, WASHINGTON, D.C.

## Pattern Variability Among Populations of the Gobiid Fish *Bathygobius soporator*

By WILLIAM N. TAVOLGA

THE common shallow water goby, *Bathygobius soporator* (Cuvier and Valenciennes), is a widely distributed and variable species, found on Neotropical coasts and islands. A recent taxonomic review of the genus (Ginsburg, 1947) has presented evidence for the allocation of various populations to specific and subspecific ranks. Other species of this genus have been described from Pacific and African regions.

Reports on the natural history of this fish have been limited to observations of Beebe (1931) and Breder (1943, 1948). Both authors have noted the remarkable color changing ability of *Bathygobius*, and the characteristic gill-like free pectoral fin rays, forming a fringe on the dorsal margins of these fins.

*Bathygobius soporator* was found to be common in the tide pools and along sandy beaches in the vicinity of the Lerner Marine Laboratory, at Bimini Island, Bahamas. Because of rapid and extensive color and pattern changes, this species was considered a useful experimental animal in studies of mechanisms of pigmentary control in fishes. However, before any such studies could be attempted, an investigation of the normal variability in color and pattern was necessary. In the course of this investigation, certain population differences were found to be associated with different habitats. The present report, then, is a presentation of correlated observations on color changes, behavior, and ecology of *Bathygobius soporator*.

The writer is indebted to the staff and facilities at the Lerner Marine Laboratory for making these investigations possible. Thanks are due to the director of the laboratory, Dr. Charles M. Breder, Jr., of the Department of Fishes and Aquatic Biology, American Museum of Natural History, for his comments and criticisms. The writer is also grateful to Dr. Lester R. Aronson, of the Department of Animal Behavior, American Museum of Natural History, for reading the manuscript and for his helpful suggestions.

### SOURCE OF MATERIAL

Representatives of three populations of *Bathygobius soporator* were studied at Bimini for a period of four weeks (August 17 to September 16, 1948). A total of 39 specimens, 20 to 72 mm. in standard length, were collected from rocky tide pools at Entrance Point, North Bimini. This was the same region described by Breder (1948) in his report on the ichthyology of tidal zone areas at Bimini. The behavior of these fish was essentially as described by Beebe (1931) for a Bermuda population. The fish swam in a darting fashion, hugging the bottom, and stopping abruptly. As a result of this quick, erratic movement and their obliterative type of protective coloration, they were difficult to see even when in motion. When disturbed, they usually darted for the nearest shaded spot or crevice, with several individuals often crowding into a small space. Color changes were observed to take place rapidly in the field, usually in close conformance to the background.

A total of 27 specimens, 15 to 84 mm. in standard length, were collected from a second population, which inhabited a terrain very similar to that of the above. *Bathygobius* was found in large numbers on "Turtle Rock," one of a series of islands along the western edge of the Bahama Bank, running south of Bimini. Turtle Rock forms a small, rocky island, about 500 feet long and 75 feet wide, and is situated approximately 2 3/4 miles south of Entrance Point. Its east shore is continuous with a gently sloping, rocky bottom. Its west side, facing the Gulf Stream, is steep and exposed to the surf. It was in the tide pools on the west side that gobies were found. The lower level pools, those inundated by the surf at low tide, were populated by *Salarichthys textilis*, *Abudeodus saxatilis*, *A. analogus*, *Eupomacentrus leucostictus*, and *E. adustus*, in addition to *Bathygobius soporator*. The fishes of the higher level pools were almost exclusively gobies. The general appearance of these tide pools differed little from those described for Entrance Point (Breder, 1948).

The third population studied in shallows on the east shore of North Bimini, facing the harbor, lived in a region extending for about a mile or more north of the laboratory grounds. Forty-two specimens from 14 to 88 mm. in standard length were collected here. At low tide, when collections were made, *B. soporator* was found at depths varying from less than 2 inches to over 3 feet. Two types of terrain were available to these fish: exposed sandy areas varying from a light greyish-brown to whitish in color; and areas thickly covered by brown algae. In both areas, numerous empty conch shells littered the bottom, where they had been discarded by the natives. Other gobies, such as *Gobionellus boleosoma* and *Gnatholepis thompsoni*, were typical inhabitants of this region. *Bathygobius curacao*, distinguishable from *B. soporator* by the smaller number of scales in the lateral line, was also found here. In addition, *Eupomacentrus leucostictus* and *Abudeodus saxatilis* were resident in this region. Most of these fishes were commonly found hiding in the empty shells or among the growths of algae.

#### LABORATORY CONDITIONS

At first, all specimens were maintained for several days in 10-gallon aquaria. These had white sand covering the bottom, were supplied with running sea water (24°-29°C.), and received light from an overhead skylight. Ten to 20 fish were kept in each tank, and they survived well in such group conditions without excessive fighting. Nipping was commonly observed, but as long as some shelter, such as a rock or shell, was provided, there was little pugnaciousness exhibited among members of a group varying greatly in size. Individuals frequently attached themselves to the glass sides of the aquaria by means of their sucker-like, fused pelvic fins. This was particularly true in crowded conditions when insufficient shelter was provided.

Light and dark environments, and black or white backgrounds, were all maintained in standing sea water, replenished daily. The standing water evidently did not interfere with normal behavior in the fishes, since, in natural conditions, they often remain confined to small tide pools where the water is isolated for many hours. *B. soporator* is a hardy species, accustomed to large changes in salinity and temperature.

For group observations, 10-inch crystallizing dishes were populated with

not more than 8 fish each, and for observations on single specimens, 200-cc. Wood's Hole dishes were used. In group conditions, individuals of the same population were usually combined. However, for certain observations, equal numbers of fish from two populations were placed in the same container.

Light was provided by a standard 100-watt frosted bulb placed about 12 inches above the containers. Observations of the effects of the dark were made either during the night or in a darkened room. Short flashes of light at infrequent intervals were used for observational purposes, since color changes, even at their most rapid rate, had a lag of 10 to 30 seconds. Background shade was controlled by means of black or white paper strips encircling the containers and passing underneath. Since the containers were circular and the light was directly from above, the effects of shady corners were thus avoided. Temperature effects on coloration and behavior over the range of change in the laboratory were found to be negligible.

#### OBSERVATIONS ON COLORATION CHANGES

All three populations of *Bathygobius* studied agreed closely with the diagnosis of *B. soporator* (Cuvier and Valenciennes) as given by Ginsburg (1947). Scales in the lateral line varied from 39 to 40, and pectoral fin rays from 18 to 20. Despite the fact that no structural differences could be found, the three populations were distinguishable on the basis of the predominant patterns displayed under both laboratory and field conditions. No exact field records were kept as to the frequencies of patterns observed, but laboratory conditions were set up in order to standardize the environment and to determine the extent and variability of pattern and color changes.

Occasional individuals were found which displayed color patterns typical of other populations, but on a group basis, the differences were highly consistent. These differences remained distinct even in mixed groups, where no significant changes could be observed after two weeks.

No sex differences in coloration were observed, such as were described by Breder (1943). The period of these observations was probably too late in the season, since no sexual activity was observed, nor were any nests or egg clutches found.

Several specimens over 75 mm. in standard length possessed patterns that were less sharply delimited from the ground color than were those of smaller examples. These differences, however, were noted in the field only and could not be seen in the laboratory. No other size differences in coloration were noted.

Any generalized description of the coloration of *Bathygobius* is inadequate, since the observer is confronted with a seemingly endless variety of changes both in pattern and color. The rapidity of these changes is also confusing. An individual may change from an extremely dark phase to an almost patternless milky-white within a period of 40 to 60 seconds. The predominant color is brown, changing to dark brown or black, or blanching to tan or cream. Ground colors of olivaceous, yellowish, slightly ruddy, or greenish variants of brown have been observed. The pattern is usually composed of six groups of transverse darker markings, which may all be of equal shape and shade or may vary in a single individual in intensity, color, size, and distinctness.

The markings may take the form of sharply delimited dark bands or bars; they may be fragmented into several narrower cross-bands; or they may be completely broken up into small spots irregularly distributed on the dorsum. The sides usually possess two or three rows of large spots, arranged in checker-board fashion and often extending along the lower jaw. Spots are usually present on the fins; the venter usually is white.

All descriptions apply to living specimens, since the pattern in preservative is often faded, and the differences between the populations are completely obliterated.

TABLE I

SUMMARY OF DATA ON FREQUENCY (IN PER CENT) OF PATTERN TYPES DISPLAYED BY THREE POPULATIONS OF *Bathygobius soporator* UNDER STANDARDIZED LABORATORY CONDITIONS

Pattern types	Specimens from tide pools at Entrance Point			Specimens from tide pools at Turtle Rock			Specimens from sandy beaches		
	Background		Total darkness	Background		Total darkness	Background		Total darkness
	White	Black		White	Black		White	Black	
A	17	1	—	28	6	—	—	—	—
B	34	6	—	40	14	—	—	—	—
C	10	48	—	8	38	2	—	—	—
D	—	9	—	—	—	—	—	—	—
E	28	3	—	17	18	3	—	—	—
F	6	3	33	—	4	24	—	—	—
G	1	18	65	1	11	62	—	—	—
H	—	9	2	—	—	8	—	14	20
I	—	—	—	—	—	—	7	33	52
J	—	—	—	—	—	—	5	22	26
K	—	—	—	—	—	—	5	11	2
L	—	—	—	—	—	—	4	13	—
M	—	3	—	—	7	—	35	6	—
N	4	—	—	6	2	—	44	1	—
Number of observations:	86	88	82	76	82	66	84	84	82

The nomenclature of the pattern types follows that shown on Figure 1. The arrangement is arbitrary, with the types placed in approximate order of their darkness and intensity. Types A to G were those most commonly seen in members of tide pool populations. Types J to N were most frequently displayed by animals from the beach population. Only the major variants of pattern types were described and figured, since minor intergradations and variations were so numerous as to defy classification.

Table I summarizes the data accumulated from laboratory observations in terms of per cent frequency of the appearance of each pattern type under the various conditions. Between 10 and 20 observations were made for each individual under each of three conditions: on white background; on black background; and in total darkness. Field observations given in the following descriptions were based on 60 to 100 specimens in each population, but the frequencies of pattern types are crude estimates. These estimates, however, were found to agree closely with the laboratory observations.

## ENTRANCE POINT TIDE POOL POPULATION

The most characteristic pattern of this population is Type C. In general, the pattern is composed of 6 sets of more or less distinct transverse bars across the dorsum. The first set consists of 3 bands on the head: across the nostrils, between the eyes, and across the occiput. The second set extends between the pectoral fins and is composed of 2 closely associated bands. The third set, also with 2 bands, is situated at the transectional level of the pelvic fins. The fourth set of 2 bands is precaudal in position, at the transectional level of the anus. The fifth and sixth sets are also double and are situated on the tail. In the following descriptions the bands will be referred to according to the transectional levels they occupy, i.e. cephalic, pectoral, pelvic, anal, and caudal. Primary variations of the basic type involve differences in the sharpness or fragmentation of the bands, and the amount of contrast between the bands and the ground color.

*Field Observations.*—The most frequent pattern phases observed were Types B and C. On exposed rock surfaces, over 50 per cent of the specimens were Type B. This pattern presented a general obliterative salt-and-pepper effect. The color was light brown or a slightly greenish or greyish tan with darker brown checks. These checks covered areas of from 1 to 5 scales each. Upon closer examination, the checks were seen to be arranged in irregular transverse rows as described for Type C above.

In shaded crevices the above pattern was modified into Type C by an extension and darkening of the individual checks. The transverse rows of checks were transformed into 6 groups of irregular bands. Laterad, the ends of the bands in each group fused, producing a roughly rhomboidal effect.

Less frequent pattern types observed were E, F, and G. Type G is an extreme form of Type C, with the contrast between the bands and the ground color very great. The bands are sharply delimited, dark brown or black in color, while the ground is a light brown or light grey. Types E and F are two grades of contrast in a pattern variant involving the accentuation of the pelvic and anterior caudal band groups. The ground color in these types was light brown.

Pattern Types A, M, and N, were seen in 4, 2, and 1 specimens, respectively. These were of rare occurrence in this population. Type A is a lighter variant of Type B, with a tan or cream ground color and small, light brown spots scattered over the dorsum with no alignment into transverse bands. Type A was the lightest pattern phase observed among any of the populations. Types M and N may be derived from Type F by a further accentuation of the pelvic and anterior caudal band groups and by a fusion of the members of these band groups into broad transverse bars.

*Laboratory Observations.*—On a white background and in strong light, the pattern type assumed in 34 per cent of the observations was Type B, with light grey or tan ground colors. Under these conditions, Type E was also quite frequent, having been recorded for 28 per cent of the observations. Somewhat less frequent were patterns of Type A (17 per cent) and Type C (10 per cent). Types F, G, and N occurred sporadically. The above patterns were observed at about the same frequency both in isolated and group conditions.

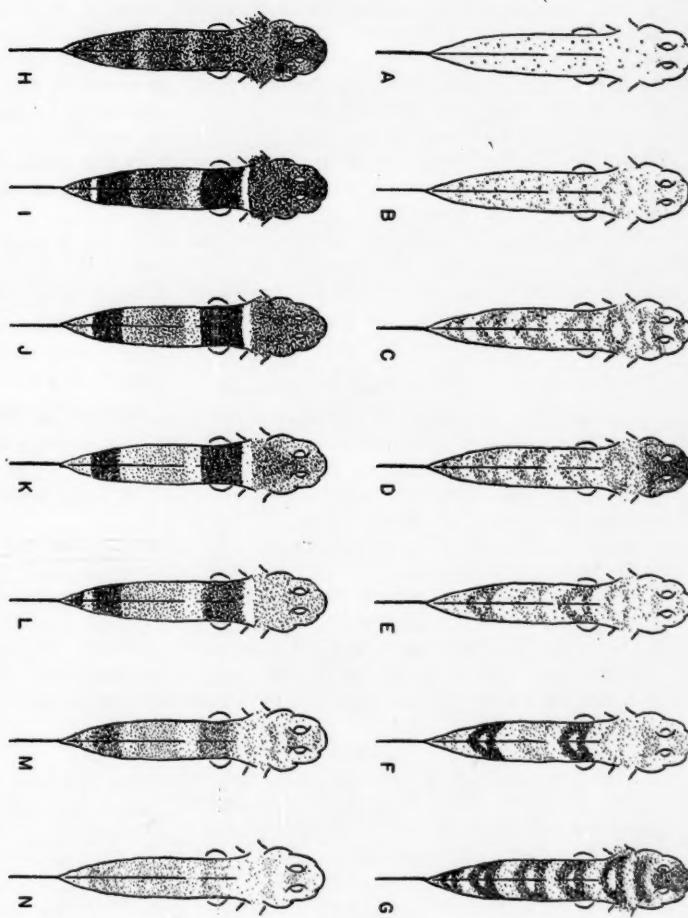


Fig. 1. Common pattern types exhibited by *Bathymobius soporator* in field and laboratory situations. Types A to G were most frequently observed in tide-pool populations, and Types I to N were displayed by members of the beach population. Type H was occasionally displayed by dark-adapted animals of all populations.

Two specimens were noted in which the Type A pattern was associated with a ruddy tan ground, giving the entire fish a pinkish hue.

On a black background and in strong light, a higher percentage of darker phases was observed, with Type C predominating (48 per cent), and Type G a poor second (18 per cent). The lighter-pattern Types A, B, E, F, and M occurred sporadically. Two previously unobserved pattern types were occasionally seen under these conditions. Type D was recorded for 9 per cent of the observations. This pattern was never seen in the field and appeared to be a variant of Type C through the accentuation and fusion of the cephalic bands. Type H, with a 9 per cent frequency, was an extremely dark phase with the pattern scarcely visible against a very dark grey ground color. This phase, the darkest observed here, was similar to that described by Breder (1943) as associated with breeding males. However, in this work, Type H was observed in immature specimens and could not be correlated with any specific external conditions.

After being left in complete darkness for periods of one or more hours, the specimens displayed pattern type G in 65 per cent of the observations, and Type F for 33 per cent. In all, the bands were very dark brown or black, in strong contrast with a light grey or light brown ground color. Type H was recorded for 2 per cent of the observations.

#### TURTLE ROCK TIDE POOL POPULATION

As is shown on Table I, this population differed little from the Entrance Point Tide Pool Population, either in field coloration or in changes induced under laboratory conditions. A slightly higher frequency for Type A was present, and the distinctions between specimens on white and black backgrounds were less pronounced.

One difference between this population and the previous one, not shown in the table, was a more common occurrence of a pinkish ground color in Type A and B patterns. As previously noted, a definite pinkish cast was seen in 2 specimens of the Entrance Point Tide Pool Population when placed on a white background. In exposed field conditions and on white backgrounds in the laboratory, about 60 per cent of the Turtle Rock specimens exhibited this pinkish appearance, accompanied by an accentuation of an occipital yellow streak.

#### BEACH POPULATION

The basic pattern of specimens from this population consisted of two broad, dark and sharply delimited transverse bars, one at the level of the pelvic fins, and one at the base of the tail. Indications of more diffuse cephalic, pectoral, and anal bars were usually present, and a distinct posterior caudal bar was often seen. The positions occupied by the bars corresponded approximately to the placement of the groups of adlineated spots or bands in specimens of the tide pool populations. The cephalic and pectoral bars were darkened and fused in the darker color phases, and the broad, diffuse anal bar was usually slightly lighter than, but confluent with, the anterior caudal bar. No specimens were observed that possessed light areas in the mid-dorsal region of the bars, as was characteristic of Types E and F in the tide pool populations.

*Field Observations.*—In exposed, sandy areas, Type M was observed in over 50 per cent of the specimens seen there. The ground color was light brown, the cephalo-pectoral and anal regions a somewhat darker brown or greyish-brown. The pelvic bar and both caudal bars were sharply delimited and dark brown in color. Frequently, the ground color was an olivaceous brown, and this was almost universal for mature individuals (70-80 mm.). The lighter, more grey Type N, and the darker Type L were seen less frequently in these exposed situations.

Individuals from areas of algal growths or from empty conch shells were mainly of Type J (over 50 per cent frequency). This pattern consisted of two bold black bars at the pelvic and basal caudal levels. The head and pectoral regions (including the bases of the pectoral fins) were fused into a solid dark brown. A broad anal bar of dark brown was in contact with the anterior caudal black bar. The region between the pelvic bar and the anal bar was a muddy grey, as was the posterior caudal bar. Two distinct, narrow light tan areas were present, one between the pectoral and the pelvic bars, and one between the two caudal bars. A darker version of this pattern, Type I, and a lighter version, Type K, occurred with lesser frequency. Occasional specimens of Type L and Type K were seen that were strongly olivaceous in ground color.

*Laboratory Observations.*—In members of this population, color changes as induced by changes in background and light were more consistent than among specimens from the tide pools. On a white background in strong light, grey or light brown phases of Types M and N were observed in frequencies of 35 per cent and 44 per cent, respectively. Darker pattern types occurred sporadically.

On a black background in strong light, the very dark Type I was recorded for 33 per cent of the observations. Lighter types were seen with progressively lower frequency. Type H (14 per cent), when seen, was indistinguishable from the Type H recorded for the tide pool populations, since the pattern was scarcely visible.

After exposure to darkness, Type I was assumed in 52 per cent of the specimens. Types H and J were the only others to be seen with any consistent regularity (20 per cent and 26 per cent, respectively). Two mature males (80 and 84 mm.) persisted with an olivaceous Type K pattern throughout this experiment.

#### OBSERVATIONS ON BEHAVIOR

The changes in pattern type and color intensity as described previously apply both to isolated individuals and to group conditions. Variations in color behavior were evident among members of a group; these variations were associated with the responses of the individuals to social situations.

As described previously, gobies in the field or in aquaria (with shelters provided) usually displayed the darker pattern phases when in concealed or semi-concealed situations. This species is territorial in its habits, and individuals will often remain within a particular crevice, shell, or shady corner, and proceed to chase all intruders. This behavior was described for *Bathygobius* and *Eupomacentrus* by Breder (1948). Similar comparisons of be-

havior were observed here. In 10-gallon stock tanks, where the amount of shelter was limited to a single rock, and there were as many as 20 fish in each tank, 5 or 6 of the specimens would hollow out depressions in the sand underneath the rock, and maintain these hollows as territories. The shady corners of the aquarium were also used in this manner. Often as many as 2 or 3 animals would share a single shelter. Those that were unable to find a shelter were chased about and finally took up residence at higher levels by clinging to the sides of the aquarium. The animals that dominated their particular territories, and were most persistent in chasing intruders, were of the darkest shade. They often showed a sudden darkening while exhibiting pugnacious behavior. The individuals without territories were of a lighter shade, usually Type B for the tide pool forms and Type M or N for members of the beach population.

Fright or disturbance, both in the field and in the laboratory, elicited a variety of responses. In 35 out of 50 trials, individuals from the beach population turned darker upon being disturbed, either by handling or swirling. Eight out of 50 trials resulted in a rapid blanching to lighter color phases, and 7 showed no effect. The same methods applied to specimens of the tide pool populations produced a blanching in 42 out of 50 trials, 2 darkening, and 6 showing no response.

Groups of 8 individuals of approximately equal size were placed in circular dishes with evenly shaded and textured background, and with direct overhead lighting. No territorial behavior was observed under these conditions. Little or no variability in color was noted. Some general activity was observed, with sporadic, random nipping. This behavior was compared to that of another territorial species, *Eupomacentrus leucostictus*, when placed into such circular aquaria. When 4 or 5 young *Eupomacentrus* were introduced into a circular aquarium, their territorial behavior appeared erratic. General activity increased and considerable fighting ensued. The close approach of other fishes was not tolerated, but no particular area was maintained as a territory for more than a few minutes at a time. When one *Eupomacentrus* was introduced into a group of several *Bathygobius* in a circular container, the latter remained relatively passive in the face of furious attacks. The introduction of a small shell into such an aquarium populated by *Eupomacentrus* and *Bathygobius*, resulted in a series of events similar to that described by Breder (1948). *Eupomacentrus* quickly took over the shell as its territory, but, being a restless and active species, often left its shelter to chase a particular intruding goby around the aquarium. Usually, during one of these forages, the unprotected shelter was taken over by another goby. Once a *Bathygobius* established itself in the territory, it remained quietly within the shelter and maintained it indefinitely. Although this experiment was repeated several times, the results were always the same, i.e. *Eupomacentrus* entered the shelter first, but within an hour or less a *Bathygobius* would take it over.

The free pectoral fin rays characterizing the genus *Bathygobius* have been assumed to be associated with respiration. Beebe (1931) and Breder (1948) have reported that under conditions of suffocation, these fishes waved the dorsal margins of their pectoral fins, spreading the free ray filaments. The correlation may well exist, and has been noted in the present investigations,

but the contention that these fin rays have a respiratory function as accessory gills is not borne out by closer examination of the filaments. Each filament consists of a segmented, cartilaginous fin ray, with a thin epithelial covering. The blood supply of the membranous portion of the pectoral fin is no greater than that of any other fin in teleost fishes in general, and the blood supply of the free filaments is probably less extensive. In addition, since the number of the free filaments is small (varying from 12 to 16), no material increase in surface area is affected by the loss of the webbing (see Breder, 1948, for photographs of these structures). The function of these filaments, then, can hardly be respiratory, as shown by the absence of the rich vascular supply and of the large surface area which would be expected in any respiratory organ. The resemblance between the fin filaments and gill filaments is purely superficial and probably fortuitous.<sup>1</sup> As for a possible current-producing function, these filaments would be quite inadequate, especially when contrasted with the already powerful respiratory system of *Bathygobius*, with its large mouth and mandible, large opercula, and associated muscles. Future investigations are necessary to explain the apparent correlation between suffocation and the fin-waving behavior.

#### DISCUSSION

The remarkable background matching ability of coloration in fishes is a phenomenon which becomes increasingly obvious as ecological studies are correlated with laboratory observations under standardized conditions. This has been reported for several species by Breder (1946, 1948); and *Bathygobius*, with its highly variable coloration, is an excellent example. In the tide pool populations, the speckled background of Aeolian limestone is matched by the animal both in exposed and shaded situations. In the tidal shallows, the light pattern phases blend with the background in exposed sandy areas, and in darker areas, the bold cross-barred pattern is highly advantageous because of its obliterative effect.

Under standardized laboratory conditions, the coloration is, of course, less successful in terms of concealment, but from such observations, evidence may be accumulated as to the origin and mechanism of these color changes. The members of the tide pool and beach populations consistently retain their differences in color behavior when faced with identical conditions. Even residence in the same aquarium did not increase the similarity between the two populations. Unfortunately, the length of the stay at Bimini was too short to observe any such changes for more than a two-week period, and experiments have been planned to find whether long term residence together under identical conditions would influence color behavior. The members of the two populations even react differently to disturbance, and this difference appears correlated with their habitat. In the tide pool gobies, fright elicits a paling response, and in the field this is associated with a dash across exposed rock surface to the nearest exit from one tide pool into a neighboring one. In the beach gobies, the most frequent color change induced by fright is a darkening and intensification of the disruptive pattern, and the frightened animals make for the nearest patch of dark mud or vegetation, where they halt abruptly.

The description by Beebe (1931) of a population of *Bathygobius* in the tide pools on Nonsuch Island, Bermuda, shows a strong diversity in coloration between this population and the ones at Bimini. Beebe reported four common color phases. The "normal" pattern phase was nearest to Type B, as described here, but differed from it in the presence of green and blue colors and the absence of any adlineation of spots. The "fear" pattern of the Bermuda gobies was unlike anything seen at Bimini. This pattern phase was described as a general dark green, with yellow fin margins, and blue spots, and was assumed upon disturbance as the animal fled to concealment into nearby patches of dark green sea weed. Beebe's description of the nocturnal pattern approximated Type L, as defined here, except for a darkened snout. The pale white coloration assumed by the Bermuda gobies on exposed sand was far lighter than the lightest pattern phases seen at Bimini. According to Ginsburg's review of the genus (1947), the Bermuda specimens observed by Beebe were probably *B. soporator sextaneus* Ginsburg, as determined by the scale and fin ray counts reported by Beebe.

The small group of *Bathygobius* studied by Breder (1943) possessed a coloration very similar to that of the tidal shallows population at Bimini. The habitat of these animals at Palmetto Key, Florida, resembled that of the beaches along the harbor at Bimini only in the presence of shells where the fish could hide.

The mechanisms of color control in fishes are still imperfectly known. Parker (1948) listed at least three factors. One is the melanophore dispersing principle of the intermediate lobe of the pituitary gland. The others are the antagonistic actions of cholinergic and adrenergic nerve endings. The action of adrenalin is quite uniform in producing a contraction of melanophores, but the actions of acetylcholine and intermedin appear to be less predictable and related to other physiological phenomena. As for the receptors concerned, the eye, of course, is of prime importance, and darker color phases are usually exhibited by fishes after optic nerve resection. The matter of countershading had led investigators to differentiate between incident light and reflected light in reference to the part of the retina affected. Sperry (1943, 1948), in his work on eye rotation in amphibians and fishes, has presented evidence for a "dorsal-ventral differentiation of retinal function." Receptors in the skin are apparently concerned with melanophore dispersion, as shown by Parker (1940, 1948). Studies on blind cave characins have shown that the pineal gland is also concerned with light sensitivity (Breder and Rasquin, 1947), and the relation of the pineal to pigmentary changes has been reviewed by Gladstone and Wakeley (1940). Psychological factors also appear to be concerned in pigmentary changes, as noted previously in the reactions of the gobies to fright stimuli. The possession of a territory or shelter, in *Bathygobius*, is associated with darker pattern phases, as described here and confirmed by Breder (1949). This may possibly be interpreted as a result of psycho-physiological changes associated with the individual's higher position in the dominance order. On the other hand, it may reflect the adaptive changes in an animal that possesses and frequents a shaded shelter, as opposed to one forced to remain in situations exposed to more light. The problem of pigmentary control, then, is quite

complex, and further study will be required to discover which mechanisms are concerned with the differences between the populations of *Bathygobius*.

Several possibilities regarding the origin of these differences exist. One is that the adaptational reflex patterns are laid down during early life as conditioned responses. Another is that the differences are genetic, having accumulated as a result of selective environmental forces. These animals, then, may be undergoing some of the earliest phases of speciation. It is most likely that a combination of these factors is involved.

Since the present work shows that there is so little intergradation between the pattern types displayed by the populations, and since the distinctions are evidently not influenced by environmental changes in adults (at least over a two-week period), the extent of geographical and ecological isolation of these populations should be considered. Breder (1943) reported that larval *Bathygobius*, measuring slightly over 2 mm. in length, were pelagic and mildly phototactic in their habits, indicating a probable free-floating and plankton-feeding phase in larval life. The growth rate of these larvae is unknown, but this is probably a relatively short phase, since specimens as small as 15 mm. in standard length were collected from tide pools and along the beaches. These individuals displayed the same behavior and the same color changes as did the larger ones. It is during this pelagic larval phase that migration can occur, since such larvae would be carried by tides and currents. Certainly other populations of *Bathygobius* exist in the vicinity of Bimini, and these may differ in greater or lesser magnitude from those already studied. Among many other factors, the amount of interchange between the populations would depend on the distances that the pelagic larvae are carried and on possible habitat preferences that may exist in these animals. One can only speculate on these factors at the present time, and future life history studies are indicated. Breder (1948) remarked that temperature differences during embryonic or larval development may produce changes not only in coloration but in scale and fin ray counts and other features considered of taxonomic significance by Ginsburg (1947).

Future investigations have been planned to determine the intrinsic, physiological mechanisms involved in the pattern differences between populations of *Bathygobius soporator*, and to elucidate the genetic and environmental factors influencing these differences.

#### SUMMARY

1. Three populations of the common shallow water goby, *Bathygobius soporator*, occur in the vicinity of Bimini Island, B.W.I. Two of these populations inhabit rock tide pools and the third lives along sandy beach areas.
2. The coloration and pattern of this species is highly variable and undergoes rapid changes in response to environmental stimuli.
3. The tide pool populations differ from the beach population in the pattern types displayed most frequently both in the field and under standardized laboratory conditions of light and background.
4. These differences are maintained in mixed groups for periods of up to two weeks, and are also evident in the reactions of individuals to fright stimuli.

5. The color behavior of these gobies is closely correlated with their habitat background.
6. Such population differences reflect diversities in color-controlling mechanisms such as light receptors or hormonal and nervous factors.
7. The above differences have originated either as conditioned responses, as a result of physical environmental effects, or from genetic processes. In the latter case, the variations probably would represent initial stages in the speciation process.

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## Remarks on Cottid Fishes Occasioned by the Capture of Two Species New to California

By ROLF L. BOLIN

RECENTLY Dr. Boyd W. Walker, of the University of California at Los Angeles, submitted to me a small cottid fish which had been dredged in fairly shallow water off Santa Rosa Island by the research vessel "Orca," of the Sefton Foundation. This specimen proved to be of unusual interest, since not only did it represent a new species but it displayed characters almost perfectly intermediate between the genera *Radulinus* and *Radulinopsis*. While the new species will not fit any genus as now characterized, I prefer, instead of erecting a completely new genus for it, to place it in a new subgenus of *Radulinus* and to reduce *Radulinopsis* to subgeneric status. With such treatment *Radulinus* requires redefinition, but it becomes a moderately compact group of five species. The allocation of all of these fishes to a single genus, even though they do display three minor lines of evolution, appears to exhibit their interrelationships to the best advantage and to contrast them with their closest relatives of the genus *Artediush* on the one hand and the *Triglops-Sternias-Prionistius-Elanura* complex (which would also probably profit by the reduction of some genera to subgeneric rank) on the other. The suggested arrangement emphasizes their similarity in body form, reduction of palatine dentition, posterior displacement of the dorsal origin, and development of a characteristic type of penis.

All measurements and counts reported in this paper have been made in the manner explained in a previous work (Bolin, 1944).

### GENUS *Radulinus* GILBERT

*Radulinus* Gilbert, 1891: 88 (genotype by original designation, *Radulinus asprellus* Gilbert).

Body slender, elongate, subcircular in cross section; no teeth on palatines; preopercular spines short and simple; gill membranes broadly united, free from isthmus; gills  $3\frac{1}{2}$ . Lateral line armed with large, strongly ctenoid, tubular scales; smaller but clearly evident scales, each in the form of a strongly inclined ctenoid ridge arising from a flat basal plate, occurring on the body above lateral line and continued forward on dorsal surfaces of head and into interorbital space; lower half of body not covered by oblique folds of skin bordered by ctenoid scales. Urogenital papilla modified to form a long, slender, evenly tapered penis in males. Origin of first dorsal fin over or slightly behind tip of opercular flap; pelvics 1,3; no branched rays in any of the fins except caudal.

While it must be admitted that the male of the new species herein discussed is unknown, and that, therefore, no direct proof of the occurrence of a penis in this form exists, I am so sure that it will be present when the

male is discovered that I have little hesitancy in using the character in the generic diagnosis.

#### ARTIFICIAL KEY TO THE KNOWN SPECIES OF *RADULINUS*

1. Second dorsal 14-17; A. 13-18; no teeth on vomer; at least one cirrus on each side of body a little below lateral line ..... 2
- Second dorsal 21-23; A. 22-25; teeth present in a narrow band on vomer; no cirri below lateral line (subgenus *RADULINUS*) ..... 4
2. Second dorsal 14-15; A. 13-15; area between lateral line and dorsal fins entirely scaled; at least three preopercular spines distinct; no slit behind the last gill (subgenus *RADULINOPSIS*) ..... 3
- Second dorsal 17; A. 18; dorsal scales restricted to a rather narrow band immediately above lateral line, separated from dorsal fins by a wide naked area; only two preopercular spines distinct; a minute pore behind last gill (subgenus *RADULINELLUS*) ..... *vinculus*, n. sp.
3. Dorsal fins separated by a marked interspace; caudal peduncle much longer than orbit; head less than 34 per cent of standard length; lateral-line scales with prominent longitudinal ridges dorsally and ventrally; dorsal row of spines along these scales not bent downward posteriorly, well separated from a single spine on postero-ventral angle of scale ..... *derjavini*  
Dorsal fins contiguous; caudal peduncle about equal in length to diameter of orbit; head more than 35 per cent of standard length; lateral-line scales with only a poorly defined ridge dorsally and none ventrally; dorsal row of spines along these scales bent downward posteriorly to approach two small spines on postero-ventral angle of scale ..... *derjugini*
4. Snout longer than eye, its length 1.4 (1.2-1.5) times diameter of orbit; nasal spines rather short, triangular; pelvic fins short, their length 1.1 (1.0-1.2) times width of pectoral base ..... *boleoides*  
Snout equal to or shorter than eye, its length 1.2 (1.0-1.4) in orbit; nasal spines long and needle-like; pelvic fins long, their length 1.9 (1.7-2.6) times width of pectoral base ..... *asprellus*

#### Subgenus *Radulinopsis* Soldatov and Lindberg

*Radulinopsis* Soldatov and Lindberg, 1930: 183. (Since the authors did not designate a type, the genotype is hereby designated as *Radulinopsis derjavini* Soldatov and Lindberg.)

Body only moderately elongate; no teeth on vomer; at least three preopercular spines with well developed points; no pore behind the last gill; dorsal scale band covering entire region between lateral line and dorsal fins; cirri present on body below lateral line; dorsal and anal fins with not more than 15 soft rays each.

Unfortunately, I have not had the opportunity of examining either of the two species allocated to this subgenus. Evidently, they have been taken only in Peter the Great Bay and, aside from the original descriptions, have been mentioned in the literature only by Taranetz (1937) who, modifying Soldatov and Lindberg's transliteration from the Russian, listed the type species as *Radulinopsis derzhavini*.

It appears that the fishes of this subgenus are the most primitive members of the group. They approximate most closely the typical cottid in body form, have comparatively few fin rays, and the scaled areas of the dorsum are extensive. However, they are specialized in the total reduction

of the vomerine dentition and in the loss of the slit behind the last gill. The closure of the last gill slit appears to be of minor significance since in those members of the genus in which it remains open it is reduced to a tiny and practically non-functional pore.

***Radulinellus*, new subgenus**

The genotype and only known species is *Radulinus vinculus*, new species. Body long and slender; no teeth on vomer; only two preopercular spines developed as evident points; a minute pore behind the last gill. Dorsal scale band about three scales in width at its widest point; cirri present on body below lateral line. Dorsal fin with 17, anal with 18 soft rays.

The only member of this subgenus represents an intermediate stage in the progressive reduction of the dorsal squamation and the elongation of the body with the concomitant increase in the number of fin rays, which reaches its culmination in the subgenus *Radulinus*. Its close relationship to *Radulinopsis* is indicated by the complete loss of the palatine dentition and the possession of cirri below the lateral line. To *Radulinus*, it is linked by the similarity of the preopercular spines and the retention of a minute pore behind the last gill, this latter feature being shared with only one of the two species (*Radulinus boleoides*) of the more specialized subgenus.

*Radulinellus*, a small scraper, the diminutive of *Radulinus*.

***Radulinus (Radulinellus) vinculus*, new species**

Body slightly depressed anteriorly, slightly compressed posteriorly; distance from dorsal origin to pelvic base 1.1 in width at pectoral base; caudal peduncle narrow, its depth about 1.8 in diameter of orbit.

Head small, 3.6 in standard length; mouth small, terminal; maxillary extending slightly beyond vertical of anterior orbital rim, its length 3.3 in head; lower jaw slightly shorter than upper, barely included; teeth small, conical, limited to elongate triangular patches on each side of premaxillary and dentary. Snout moderately steep, rather short, 1.2 in orbit; nasal spines strong, erect; anterior nostrils in short tubes with posterior margins somewhat elevated; posterior nostrils pore-like. Eye moderate in size, somewhat longer than high, 3.1 in head; interorbital space very narrow, about 0.7 as wide as posterior end of maxillary, transversely flat, the orbits without elevated rims; occipital region flat, top of head without ridges or spines. Two short, broadly triangular, preopercular spines; the two lower spines, common in other cottids, represented by very broad, slightly rounded, and definitely non-spinous expansions of the preopercular border. Opercular flap ending in a rounded lobe, extending about 0.4 of an orbital diameter behind upper end of gill opening.

Lateral line following a descending course opposite basal half of pectoral fin, then continued as a practically horizontal straight line, armed with scales which are strongly ctenoid along their upper and posterior borders. Small ctenoid scales covering posterior half of interorbital space and continued in a triangular patch on occiput. From the anterior or basal angles of this triangular patch, scales extend downward behind each orbit and then backward just above the suborbital stay to the base of the upper preoper-

cular spine. Another narrow band of small scales extends backward from the posterior orbital margin, passing just above upper end of the gill opening and continuing as a band of slightly larger elements immediately dorsal to the lateral line; this latter band is about three scales in width anteriorly but becomes reduced to a single line of scales posteriorly and terminates slightly anterior to the end of second dorsal. No scales below the lateral line in the area covered by the pectoral fins. A single cirrus on each side slightly below the lateral line and about on the vertical of the origin of the second dorsal fin; no other cirri on head or body. Anus about 0.5 of an orbital diameter in front of anal origin.

Origin of first dorsal slightly behind tip of opercular flap; base of fin 2.3 in base of second dorsal; first spine somewhat shorter than second which is abruptly shorter than third, so that there is a slight indication of a notch in the anterior profile of the fin; posteriorly, the fin is bluntly rounded; sixth spine longest, about 1.5 in base of fin. Second dorsal contiguous to first dorsal, its origin about over second anal ray, its last ray over terminal anal ray; base of fin about 2.5 in standard length; fifth to ninth rays subequal and longest, 2.8 in base of fin; fin profile very gently rounded, its posterior tip somewhat angular. Origin of anal about midway between tip of snout and tip of last anal ray when depressed; base of fin slightly longer than that of second dorsal; seventeenth ray the longest, slightly shorter than longest dorsal spine and 3.8 in base of fin; profile of fin similar to that of second dorsal. Base of upper pectoral ray slightly anterior to dorsal origin; base of fin moderately procurent, rather narrow, its width 3.0 in sixth or seventh ray, which is longest and extends about to vertical of fourth dorsal ray. Pelvic base about midway between tip of snout and fourth anal ray, its length 1.4 times width of pectoral base; middle ray longest, inner ray shortest. Caudal truncate or very slightly rounded, its length 1.7 in anal base.

Measurements in per mille of standard length, based on the type, 39.0 mm. in standard length: distance from first dorsal to pelvic 146; distance from second dorsal to anal 136; depth of caudal peduncle 49; width at pectoral base 164; length of head 274; length of maxillary 82; length of snout 74; diameter of orbit 90; distance from snout to first dorsal 277; length of first dorsal 177; height of first dorsal 115; distance from snout to second dorsal 479; length of second dorsal 407; height of second dorsal 144; distance from snout to anal 454; length of anal 420; height of anal 110; distance from snout to pectoral 261; width of pectoral base 100; length of longest pectoral ray 302; distance from snout to pelvic 251; length of pelvic 128; length of caudal 243.

Fin and scale formulae: D. X-17; A. 18; P. 17; V. I,3; C. 7 branched; Ll. 35.

Color in alcohol light brown with darker brown cross bars, one under first dorsal and two under second dorsal; these are wide dorsally but narrow abruptly toward the lateral line. A narrow band of similar color extends entirely across caudal base. A less well defined dark area occurs on the sub- and postorbital regions of the head and tends to fuse with the anterior cross bar of the body, but a roughly diamond-shaped light area is con-

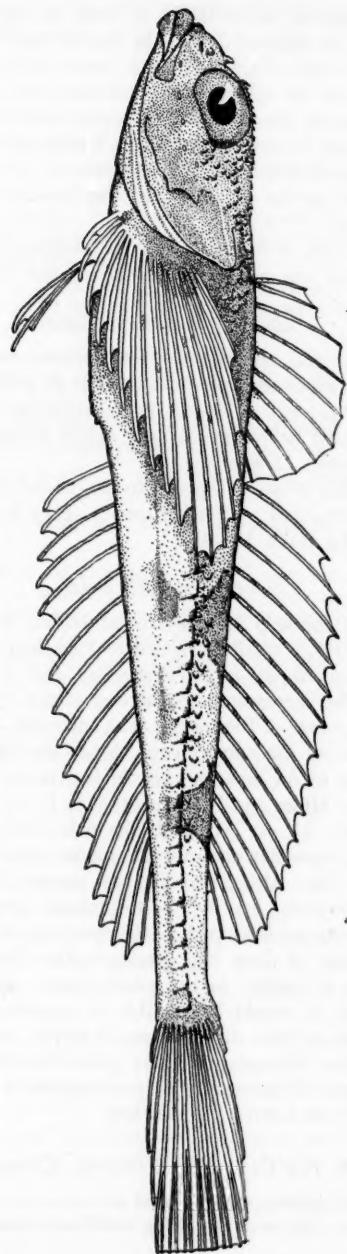


FIG. 1. *Radulinus (Radulinellus) vinculus*, n. sp.

spicuous on the midline immediately in front of the first dorsal fin. A longitudinal streak of pigment below the lateral line tends to expand into blotches below the cross bars and to a lesser extent between them. A smudge of dark color on upper part of pectoral base and very faint indications of dark bars on the rays of the pectoral and dorsal fins.

The type and only known specimen is a female taken January 28, 1949, at Bechers Bay, Santa Rosa Island, California, at a depth of 15 fathoms. It is number 15491 in the collections of the Natural History Museum of Stanford University.

The name *vinculus*, a link or means of binding, refers to its position intermediate between and connecting *Radulinus* and *Radulinopsis*.

#### Subgenus *Radulinus* Gilbert

Body very long and attenuated; teeth present in a narrow band on vomer; only two preopercular spines developed as evident points; pore behind last gill either present or absent; dorsal scale band reduced to a single line of scales; no cirri below lateral line; dorsal fin with not less than 21, anal with not less than 22 soft rays.

The fishes of this subgenus appear to be limited to water of moderate depth off the western coast of North America. They have been described in detail and figured by Bolin (1944).

#### *Synchirus gilli* Bean

While masses of the kelp *Macrocystis integrifolia* were being pulled into a skiff on July 6, 1949, a small individual of *Synchirus gilli* was accidentally captured in the southern part of Monterey Bay, Lat.  $36^{\circ} 36' 57''$  N., Long.  $121^{\circ} 53' 50''$  W. This represents a southern extension of approximately 1,000 miles in the known range of the species. The specimen, a female 25.7 mm. in standard length, was of the same brown color as the alga upon which it was found. The number of fin rays and lateral line pores agrees well with the counts presented by Miller and Erdman (1948): D. X-20; A. 19; P. 22; V. I,3; C. 9 branched; Ll. 40. Although the fish is in perfect condition, it shows no trace of postocular cirri nor of spinous scales between the lateral line and the dorsal fins. Miller and Erdman suggest that the lack of these features in some specimens may be due to museum wear, but I feel satisfied that they are entirely undeveloped in the specimen at hand.

With the addition of these two species to the fauna of California, the key to the genera of cottids in my earlier work (Bolin, 1944) becomes obsolete. Ordinarily, it would be feasible to supplement the key by the interpolation of one or two dichotomies. However, with the expansion of *Radulinus*, the fishes belonging to that genus fall into widely separated sections and, instead of attempting to put together a patchwork, it seems advisable to present an entirely revised key.

#### ARTIFICIAL KEY TO THE GENERA OF COTTIDAE KNOWN FROM CALIFORNIA

1. Pelvic fins entirely lacking, skin loose and lax ..... *Ascelichthys*  
Pelvic fins present; skin firm, not sliding readily over deeper tissues ..... 2

2. Pectoral fins connected to each other ventrally, of 21-24 rays ..... *Synchirus*  
Pectoral fins entirely separate, of 11-20 rays ..... 3
3. V. I,5 ..... 4  
V. I,2-I,4 ..... 6
4. Body naked; A. 11-13; a large, broad-based, flap-like cirrus extending longitudinally along midline of snout ..... *Scorpaenichthys*  
Body with scales; A. 22-24; no cirrus on midline of snout ..... 5
5. Dorsal spines XVII-XVIII; dorsal part of body covered by small spine-like scales arranged in crescentic groups and appearing like large ctenoid scales; ventral part of body with oblique spinous folds; no enlarged spinous scales extending along dorsal base ..... *Jordania*  
Dorsal spines XII-XIII; most of body hispid with irregularly arranged, minute, spinous scales; a series of enlarged scales, each bearing a very strong curved spine, just below base of dorsal fins ..... *Paricelinus*
6. Body markedly compressed throughout; dorsal rays 22-29; P. 11-14; body almost entirely covered by small, close-set, dermal papillae which give it a granular appearance ..... 7  
Body depressed or subcircular in cross section anteriorly; dorsal rays 9-23; P. 12-20; no granulation of small dermal papillae on body ..... 8
7. Gill membranes joined to isthmus; pelvic fins extending about to anal origin ..... *Nautichthys*  
Gill membranes free from isthmus; pelvic fins extending less than half way to anal origin ..... *Blepsias*
8. Dorsal fins continuous, the membrane from last spine attached to basal 0.3 or more of first ray; large ctenoid scales, in oblique rows, forming a well defined band below lateral line and extending about to caudal base .. *Hemilepidotus*  
Dorsal fins contiguous or separate (rarely the membrane from last spine may be attached to extreme basal portion of first ray); scales below lateral line absent, represented by minute prickles, or restricted to area covered by pectoral fins ..... 9
9. Gill membranes completely joined to isthmus ..... 10  
Gill membranes free from isthmus, or at least forming a distinct free fold across it ..... 12
10. Dorsal rays 9-12; A. 6-9; lateral-line scales developed into conspicuous, heavy, bony plates ..... *Enophrys*  
Dorsal rays 15-21; A. 11-20; lateral-line scales not evident ..... 11
11. Upper preopercular spine long and antler-like ..... *Leptocottus*  
All preopercular spines simple ..... *Cottus*
12. Area between dorsal fins and lateral line with well developed scales in oblique or longitudinal bands, or covering entire area ..... 13  
Area between dorsal fins and lateral line entirely naked, or with minute prickly scales ..... 17
13. V. I,2; dorsal scale band two scales in width, extending a little below dorsal fins and well above lateral line ..... *Icelinus*  
V. 1,3; dorsal scale band more than two scales in width, or immediately above lateral line and far removed from dorsal fins ..... 14
14. Upper preopercular spine antler-like; first dorsal spine produced, much longer than second; first dorsal fin deeply notched between third and fourth spines ..... *Chitonotus*  
Upper preopercular spine simple to multifid, but not elongate and antler-like; first dorsal spine not produced; first dorsal fin without pronounced notch ..... 15

15. Anus much nearer pelvic base than anal origin in adult, about midway between these points in very young ..... *Orthonopias*
- Anus not notably advanced in position, close to anal origin ..... 16
16. Body slender, distance from dorsal to pelvic 10-15 per cent of standard length; no teeth on palatines; dorsal origin about over tip of opercular flap, far behind upper end of gill opening ..... *Radulinus*
- Body heavy, distance from dorsal origin to pelvic base 20-30 per cent of standard length; teeth present on palatines; dorsal origin over or anterior to upper end of gill opening ..... *Artedius*
17. D. V-VII-10-13; P. 17-20; 14-17 pores in lateral line ..... *Zesticelus*
- D. VII-X-14-19; P. 12-18; 34-43 pores in lateral line ..... 18
18. Anus immediately in advance of anal origin ..... *Oligocottus*
- Anus located in middle third of distance between pelvic base and anal origin ..... 19
19. Anterior end of first dorsal not elevated, first spine about equal to, or shorter than, third spine; a large postorbital cirrus and one or more cirri on base of opercular flap ..... *Clinocottus*
- Anterior end of first dorsal strongly elevated, first spine about twice as long as third spine; no postorbital cirrus and none on base of opercular flap ..... *Leiocottus*

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HOPKINS MARINE STATION, PACIFIC GROVE, CALIFORNIA.

## The Systematic Status of *Hyla septentrionalis*, the Large Tree Frog of the Florida Keys, the Bahamas and Cuba

By GEORGE S. MYERS

### I. INTRODUCTION

The large tree-frog of Cuba, the only native *Hyla* of that island, is found also on the Isle of Pines, the Bahamas and the Cayman Islands. More recently it has been discovered on Key West and Lower Matacumbe Key, in the Florida Keys, and thus enters the North American fauna. Of late it has been formally called *Hyla septentrionalis* Boulenger (Stejneger and Barbour, 1943: 213), or *Hyla septentrionalis septentrionalis* Boulenger (Barbour, 1937: 94). The question of its specific or subspecific status not having been properly settled, the name *septentrionalis* itself having been found to be of doubtful validity, and the genesis of this ill-fitting specific appellation being intrinsically of some interest, the following notes are presented.

### II. SYSTEMATIC STATUS

#### a. Previous Treatment

So far as the writer can find, *Hyla septentrionalis*, when recognized at all, was invariably accorded full specific rank until 1937. In that year Barbour issued his third list of the West Indian herpetofauna, "departing" as he said "from the general custom not always followed, of designating all or most island forms binomially. The practice of using trinomials for races that are obviously closely related has become so general, that I present herewith some attempts to show relationship in this way" (Barbour, 1937: 77).<sup>1</sup> Thus, on page 94, he reduces the three closely related hylas of Cuba, Hispaniola and Jamaica, to subspecific rank, as follows:

- Hyla septentrionalis septentrionalis* (Boulenger)
- Hyla septentrionalis dominicensis* (Tschudi)
- Hyla septentrionalis brunnea* (Gosse)

Parenthetically, it should be noted that this arrangement is nomenclaturally erroneous, as Mertens (1939a: 84; 1939b: 35) has already pointed out. If these three forms are but subspecies, the oldest name should of course form the "typical subspecies." Tschudi's name (1838) is the oldest, Gosse's (1851) next and Boulenger's (1882) the most recent. The Cuban frog would be more properly called *Hyla dominicensis septentrionalis*, if its relationship to the Hispaniolan one is subspecific only. Moreover, if parentheses are used at all, the International Rules (Article 23) specify that they shall be used about the author's name only when the generic name is different from that under which the species was first described. There should be no parentheses about Boulenger or Gosse.<sup>2</sup>

The writer protested Dr. Barbour's wholesale "subspeciation" of West Indian amphibians and reptiles (*in: Burt and Myers, 1942: 22-23*, under

<sup>1</sup> Barbour's statement is slightly amplified by Barbour and Shreve (1937: 377-378).

<sup>2</sup> Stejneger and Barbour's *Check List* consistently violated Article 23 in this particular.

*Anolis wattsi*), and reiterated his position on the question of species and subspecies elsewhere (Myers, 1942: 12-13). These protests elicited a characteristically courteous and rather contrite personal reply from the late Dr. Barbour, and seem to have been the genesis of some of the late Dr. Stejneger's remarks in the first paragraph of the introduction of the 1943 *Check List*. In any event, *Hyla septentrionalis* appeared as a binomial in the *Check List* (p. 213). However, certain authors (e.g., Lynn, 1940: 19; and Mertens, 1939a and b) have held with Barbour's 1937 subspecific treatment, although no one has really discussed the matter.

#### b. *Nature of the Population*

The best discussions of the relationships of *septentrionalis* with its supposed close relatives, *dominicensis* of Hispaniola and *brunnea* of Jamaica, are those of Barbour (1910: 288), Dunn (1926: 123-126) and Noble (1927: 95-97). From these papers, and others, the following picture emerges: the genus *Hyla* has a peculiar distribution in the Greater Antilles. In Hispaniola there are four species, *H. dominicensis*, *H. vasta*, *H. heilprini*, and *H. pulchrilineata*, all endemic. In Jamaica there are four, *H. brunnea*, *H. lichenata*, *H. mariana*, and *H. wilderi*, all endemic. The primitive stock seems to be represented in the three islands by *septentrionalis*, *dominicensis*, and *brunnea*, all rather similar. In Hispaniola, this stock presumably has given rise to the gigantic *vasta*, as well as two smaller species, *heilprini* and *pulchrilineata*. In Jamaica, this stock apparently has given rise to the gigantic *lichenata* and two smaller forms, *marianae* and *wilderi*. But in Cuba, only one species, representing the primitive stock, is present—*septentrionalis*, similar in size and general appearance to *dominicensis* and *brunnea*.

Although life-history data for *pulchrilineata* are still missing, the other three Hispaniolan species of *Hyla* breed in different sorts of streams or ponds in the forest, and their tadpoles are of the normal type, with many tooth rows (Noble: pl. 9). Mertens (1939b: 35), however, says that *dominicensis* also breeds in cisterns. In Jamaica, all four endemic species have very specialized breeding sites—the water held by "wild pines" (Bromeliaceae)—and the tadpoles of all four have highly specialized mouthparts with greatly reduced tooth-rows (Dunn: pl. 2). The single Cuban species, *septentrionalis*, is said to breed in cisterns and rain barrels (Grant, 1940: 12; Carr, 1940: 62). In other words, of the supposedly primitive stock of West Indian *Hyla*, *brunnea* of Jamaica has specialized tadpoles and a very specialized breeding site, whilst the Hispaniolan *dominicensis* and the Cuban *septentrionalis* do not. Incidentally, the tadpoles of *septentrionalis* have not been adequately described, but they are presumably somewhat similar to those of *dominicensis*.

Dunn says that the call of the Jamaican *brunnea* is very like that of *septentrionalis* but distinguishable from it. Cochran (1941: 16) points out that *dominicensis* is easily separable from *septentrionalis* on leg length alone, but she does not mention *brunnea*. Dunn (1926: 123) refers to the evident fact that not only *brunnea*, but also its other Jamaican congeners, differ from the Cuban and Hispaniolan species in the prominent terminal nostrils. Mertens (1929b: 35) says that *brunnea* appears to be closer to *dominicensis* than to *septentrionalis*, but he also notes that the Cuban frog differs from the His-

paniolan in the wartier skin and, in life, in the presence of a green color which *dominicensis* never exhibits.

The Cuban frog appears to be a good traveller. It has gotten to the Bahamas and the Florida Keys, which do not appear to have had any Tertiary connection with Cuba, but there is a possibility that man may be responsible. The absence of derivative species in Cuba would argue for a shorter inhabitation of that island than that of *dominicensis* in Hispaniola or *brunnea* in Jamaica. One is inclined to postulate that *septentrionalis* or its ancestral form came to Cuba directly from Hispaniola, which would not necessarily indicate island-hopping ability, for there is good evidence that these islands have been connected in the Tertiary (see Darlington, 1938, and Myers, 1938). In any event, either Jamaica or Hispaniola, which have been connected, is a likely center of origin for this group of frogs, but there is no good evidence favoring one or the other. Of course there is W. D. Matthew's excellent rule that peripheral forms are likely to be more "primitive" than those existing at the same time at the center of distribution. If this be applicable to these frogs, *septentrionalis* should be the most generalized or "primitive," and Jamaica should be the original home of Greater Antillean *Hyla*. Certainly *brunnea* is the most specialized species of the three.

In connection with this, it may be recalled that Cuba, Hispaniola and Jamaica have, in their herpetofauna and ichthyofauna, a number of groups similar to these frogs, in which each of the three islands is inhabited by an apparently vicarious (allopatric) form or forms. The fish genus *Limia* is a case in point, with one form in Cuba and several in Hispaniola and Jamaica<sup>8</sup>. But zoogeographical relationships are almost invariably from Cuba to Hispaniola to Jamaica (or vice versa) and never directly between Jamaica and Cuba. Moreover, the Hispaniolan fauna, especially that of the southwest peninsula of Haiti, would seem in most instances to be closer to that of Jamaica than to that of Cuba. Thus we should expect *brunnea* to be related to *septentrionalis* through *dominicensis* and not directly, and to be closer to the latter than to the Cuban frog. *Hyla brunnea*, in the adult and presumably in the tadpole as well, seems to be much more different from the Hispaniolan and Cuban frogs than they are from each other, but insofar as the inadequate available evidence goes, there is not too much to show that *brunnea* is closer to *dominicensis* than to *septentrionalis*, as Mertens believed (1939b: 35).

*Hyla dominicensis* is unquestionably wholly distinct from *brunnea*, on the basis of nostril position, leg length, structure of tadpole, and breeding site. Practically the same can be said for *septentrionalis*, for although its tadpole is not described, there is little chance that it will turn out to be like that of the bromeliad-inhabiting *brunnea*. The chief difficulty is with the inter-relationships of the Cuban and Hispaniolan frogs. They do not appear to differ much in breeding sites and presumably in tadpole structure, but the adults seem always to be clearly separable on skin structure, leg length, and, in life at least, by color. Other differences pointed out by various workers, including

<sup>8</sup> It is interesting to note that the Cuban *Limia vittata* (Guichenot) has a very close but abundantly distinct allopatric relative in the Hispaniolan *L. melanonotata* Nichols and Myers. However, the latter is even more closely related to its own sympatric relative, *L. nigrofasciata* Regan (which often occurs in the same pools), than it is to *vittata*. In addition, Hispaniola has a series of species of *Limia* not close to these but similar to Jamaican species (Myers, 1935). That Goldschmidt (1940: 160-161), on Breider's evidence, cannot call these good species is proof of the dangers of speculating upon genetic results without knowledge of the species themselves.

Duméril and Bibron (1841: 541) and Nieden (1923: 194-5), do not seem to be of much value. The webbing of the outer fingers, as well as the interorbital width, may be of value when properly investigated in large series of specimens of comparable sizes, but there is nothing in the literature regarding these characters that is usable.

Although the Stanford Museum has a fairly good series of *septentrionalis* from Cuba, the Isle of Pines, and Key West, the writer has not had adequate material of either *brunnea* or *dominicensis*. He therefore hesitates to attempt a key to these three forms, but the absence of any published synoptical table of differences, by someone who has compared abundant good material of all three, makes it seem that a compiled key might serve until something better is offered. It is notable that not one of the different modern American authors who has published detailed formal descriptions of any one of these three species (Barbour and Ramsden, 1919; Lynn, 1940; Grant, 1940; Cochran, 1941) has given a description strictly comparable with those of the other authors. Each omits entirely to mention points others have considered valuable in separating one or another of these frogs. In the present instance, this vitiates much of the only purpose of detailed description.

Perhaps the writer may be pardoned a brief digression on this matter of descriptions. It seems to have been the late Dr. Stejneger who initiated the present widespread American herpetological custom of composing a formal specific description from the detailed description of an individual specimen accompanied by notes on the variation of the other examples in hand. When used in the description of a type specimen, this method has the advantage of making clear the exact taxonomic characters of a specimen to which a name is tied, and avoids the possible danger that two different forms may be confused in a type description. But beyond this *purely nomenclatural* utility, the method has little conceivable value except to enable a hurried systematist to deliver an imposing description without taking time to examine in detail more than a single specimen. To use this method in a general systematic treatise, except as an adjunct, where the identity of types or aberrant individuals is in question, is little less than a fraud upon the scientific public, chiefly because the authors so using it are usually purely perfunctory or woefully remiss in giving the full details of variation seen in the bulk of their material. In a treatment of natural populations, what we are interested in is the nature of the population in hand, not of any individual, unless that individual happens to be intrinsically of special importance.

Returning to our problem, the following compilation of the differences between our three frogs is presented:

*Hyla septentrionalis* (Cuba, Isle of Pines, Cayman Islands, Bahamas, Florida Keys)

1. When leg is brought forward along body, tibiotarsal joint reaches anterior corner of eye. (Adult.)
2. Snout-tip rounded-acuminate in profile, the upper surface inclined and the nostrils not in a terminal position. (Adult.)
3. Skin of dorsum beset with rather widely spaced, rounded, conspicuous warts,<sup>4</sup> except when the live frog is in poor condition, or in poorly preserved specimens. (Adult.)

<sup>4</sup>The warty skin is very well illustrated in the upper of the three photos given by Wright and Wright (1933: 126). The nostril position is also well shown. The same photos are given in later editions of Wright and Wright.

4. Coloration changeable, but ground color frequently green or greenish in life; when the dorsal pattern is well displayed it is composed of a number of medium to large discrete spots, darker on the edges, which are often elongated lengthwise. (Adult.)

5. Breeds in still water, chiefly in non-forested regions.

6. Tadpole not described, but probably somewhat similar to that of *dominicensis*; living in pools or cisterns.

*Hyla dominicensis* (Hispaniola, that is, Haiti and the Dominican Republic)

1. Tibiotarsal joint reaches tip of snout. (Adult.)

2. Snout-tip much as in *septentrionalis*, the nostrils not terminal in position. (Adult.)

3. Skin of dorsum fairly smooth above, warts (if present) mostly confined to upper surfaces of hind legs. (Adult.)

4. Coloration changeable, but ground color never green or greenish in life; when the dorsal pattern is displayed it is composed of a coarse reticulation or mottling, often with two irregular, dark, lengthwise marks above the shoulders and sometimes a large, similar, but more irregular spot further back. (Adult.)

5. Breeds in pools and cisterns, in or out of the forest.

6. Tadpole with labial disk complete and not broken above; at least two rows of "teeth" above and four below the beak; living in forest pools or cisterns.

*Hyla brunnea* (Jamaica)

1. Tibiotarsal joint reaches middle of eye. (Adult.)

2. Snout-tip abruptly truncated in profile, its anterior surface vertical, and the nostrils set in a terminal position at upper limit of the truncated portion.<sup>5</sup> (Adult. This is a character shared by all four of the Jamaican hylas, according to Dunn, and differentiates them as a group from the Cuban and Hispaniolan species.)

3. Skin of dorsum smooth. (Adult.)

4. Coloration changeable, but ground color never green or greenish in life; when the dorsal pattern is displayed it is variable, usually consisting of many small brown spots, but sometimes of irregular mottling posteriorly and a variable very large irregular dark blotch, roughly X-shaped, from between the eyes to the middle of the back. (Adult.)

5. Breeds exclusively in the water caught between the leaves of "wild pines" (Bromeliaceae) in the forest.

6. Tadpole with labial disk degenerate and interrupted above; only a single row of "teeth" above the beak and none below; living and transforming in "wild pines."

c. Species or Subspecies

The sharply different larvae of *brunnea*, which perhaps could not exist if placed in a pond or cistern, and the adult differences between all three species pointed out by Barbour, Dunn, and Cochran, make it clear that we are dealing with three distinct, non-intergrading populations. One of them, *brunnea*, stands well off from the other two in adult and tadpole structure, but the two similar forms also exhibit strong, adult differences. Moreover, that the *brunnea* and *dominicensis* stock seems to have had time enough to evolve three other endemic species in Jamaica and three in Hispaniola indicates that the primitive stocks on these two islands have been separated for a considerable period. Under the circumstances, the average systematist would have no hesitation in pronouncing not only *brunnea*, but also *septentrionalis* and *dominicensis*, to be good species. The writer believes them to be.

However, it is not entirely clear that full specific recognition would be accorded to these three forms, even the very distinctive *brunnea*, by those who have adopted the *Rassenkreis* concept. The species definition given by Mayr (1942: 120) would relegate to subspecific rank not only races which demonstrate intergradational hybridism but also populations "which are potentially

<sup>5</sup> The truncated snout and the nostril position are fairly well shown by Lynn (1940: pl. 1, fig. 1, side view of head).

capable of (interbreeding) in those cases where contact is prevented by geographical or ecological barriers." I do not believe anyone can say whether *septentrionalis*, *brunnea*, and *dominicensis* would interbreed if brought together, without experimental evidence, even though the breeding site and tadpoles of *brunnea* are very specialized. The different types of breeding sites selected might not completely isolate these animals under conditions that could easily be produced if the three islands were to be connected, and the known extra-specific mating tendency of frogs makes it certain that cross-mating would occur now and then if two or all three were simultaneously in breeding condition in the same vicinity. Perhaps the adult and larval differences are sufficient to cause an experienced systematist (see Mayr, 1942: 121) judiciously to infer (guess, the writer would call it) that the forms in question would or would not interbreed and produce fertile offspring, but this is not clear to the writer and he doubts that it would be clear to any herpetologist. It is entirely possible that these frogs, even the very different *brunnea*, have not yet become sufficiently different genetically to prevent interbreeding and the production of fertile offspring, especially under artificial laboratory conditions, and if they have not, they would be subspecies under the *Rassenkreis* concept.

The writer has explained his objection to this phase of the *Rassenkreis* concept in the two references cited above (pp. 203-204) but he wishes to add just a few words more. The modern systematist can no longer feel that he has come to the end of his problems by the utilization of a few morphological characters. As the writer pointed out twenty years ago,<sup>6</sup> systematics will not be complete until not only every morphological characteristic but also every life process has been exhausted in the search for the true nature and phylogeny of every natural population. Of course, this sets up an unattainable ideal, but one which is the inescapable result of careful analysis of the goals of systematics. Moreover, it emphasizes the increasingly evident fact that modern systematics is primarily concerned with *knowledge of populations*, and that classificatory arrangement and nomenclature are of only secondary importance.

Species are large, closed biological population systems. Subspecies, as most understand them, are incompletely closed biological systems within species. But there are numerous borderline cases and it is upon these that the ordinary and *Rassenkreis* concepts differ. Adherents of both concepts are plagued by the necessity of guessing about intergradational hybridism where available specimen-samples are insufficient. But *Rassenkreis* adherents are, in addition, forced to guess about the interbreeding potentials of populations clearly separable (hence definable) by morphological or other characters, which are reproductively isolated by geography or ecological factors, and which, therefore, behave in most ways like the very best of "Rassenkreis species."

It is clear that we shall never be able to test experimentally the "interbreeding potential" of more than an negligible fraction of the millions of existing species and subspecies. For practical purposes, therefore, we must almost always guess at this "interbreeding potential." The writer fails to see that the adoption of a set of species-criteria which includes such a condition has notably improved systematics. At best, it has focused the attention of certain non-progressive systematists upon the dynamic features of their field. At worst, it

misleads by an assumption of near-omniscience on the part of the systematic expert, and by a certain implied flavor of "modern progressive biology," without a great deal of basis for either. In truth, it may be that the whole question of a working species definition would be best solved by retention of the non-intergradation criterion for normal systematics, and the use of a special terminology (as certain botanists have suggested) for those relatively few cases which have been thoroughly investigated experimentally. But the *Rassenkreis* adherents experiment no more with their species than do other systematists.

The writer is strongly of the opinion that the old species-criterion of clear non-intergradation is a perfectly sound one, biologically, for the routine recognition of that type of population which we call the species, especially if we remember that it refers to more than morphological characters. Most species recognized by means of this older criterion will also be species under Mayr's or Rensch's methods of procedure. When they are not, the writer cannot for the life of him see that a guess that populations will interbreed notably improves our biological knowledge, or that calling such populations subspecies is somehow more biologically true or "dynamic" than calling them species. Guessing about interbreeding simply introduces an extra and quite unnecessary uncertainty into systematic procedure, and without any gain. In fact, there is a real loss in that the systematist is forced to make an assumption (about interbreeding) for which he often has no real basis, instead of depending solely upon concrete evidence. Finally, in dealing with those closely related populations over which the *Rassenkreis* adherents and the non-intergradation adherents would differ, whether they are tagged "species" or "subspecies" seems to be quite immaterial, biologically. What we are interested in is the true nature of a population, its relationships and its phylogeny, and until we have good experimental evidence, a non-intergradation label is just as good as a *Rassenkreis* label. Better, indeed, for it is thoroughly objective and lacking in subjective uncertainties.

Under this older criterion, and perhaps under the *Rassenkreis* concept as well, *Hyla septentrionalis*, *H. dominicensis*, and *H. brunnea* are all distinct species.

### III. NAME AND SYSTEMATIC HISTORY

#### a. Meaning of the Name

The Latin name *septentrionalis* means "of the Septentriones," the seven large stars of *Ursa Major*, the Great Bear or Big Dipper, two of whose stars point to *Stella Polaris*, the Pole Star. The name therefore signifies "of the north" and has been applied to many northern animals. Herpetologists are familiar with it as the specific name of the northern or mink frog, *Rana septentrionalis* Baird, and the northern swamp cricket frog, *Pseudacris septentrionalis* (Boulenger). How a relatively southern member of the genus *Hyla* came to receive this name is of some interest, but can best be explained in connection with the systematic history of the frog.

#### b. Systematic History

Older authors credited the name *Hyla septentrionalis* to Tschudi (1838), but in 1905 (p. 330), Stejneger said: "This name must be dated from Boulenger (1882), as both Schlegel's *Hyla septentrionalis* of 1837, and Tschudi's

*Dendrohyas septentrionalis* of 1838, are absolute *nomina nuda*." Since 1905, North American herpetologists have followed Stejneger without apparently noticing that *septentrionalis* of 1882 is antedated by two specific names applied to specimens of this species by Cope in 1863. However, other circumstances make it unnecessary to change the name.

In 1838 (p. 33), J. J. Tschudi noticed a new frog in the following words: "*Hyla septentrionalis* (Mus. Par. et Lugd. Schlegels Abbild. etc. Dec. 1, p. 21) ist nicht mit der vorhergehenden Species zu verwechseln; sie ist an ihrem constanten Färbungs-systeme leicht zu erkennen, und nähert sich durch dieses ziemlich der *Hyla versicolor* Lec. Hr. Noël brachte sie vom nördlichsten Punkte Norwegens, vom Nordkap 71° N. B. in mehrern Exemplaren nach Paris; es ist noch unbekannt, wie weit sich dieses Thier nach Süden hin verbreitet." Tschudi's subsequent reference on page 74 adds nothing of importance save to refer the species to the genus *Dendrohyas*, together with *versicolor* and several others.

*Nordkap* is, of course, North Cape, at the northern tip of Norway, and the name *septentrionalis* would well befit so northern a frog. Of course, a suspicious zoologist, even in 1838, might have been pardoned some skepticism regarding tree frogs from the icy north, especially when they arrived at the Paris Museum as a *présent de Noël*! However, the whole thing was cleared up by Duméril and Bibron in 1841 (p. 540).

It appears that a certain M. Noël Delamorinière, previous to 1837, presented to the Paris Museum some tree frogs labelled as from North Cape. While preparing their *Érpétologie Générale*, Duméril or Bibron tentatively labelled this bottle of frogs *Hyla septentrionalis*, and apparently examples so labelled were given to Schlegel in Leiden or were perhaps seen by him in Paris.

Parenthetically, it should be noted that Schlegel, who was then preparing his *Abbildungen*, came to the completely erroneous conclusion that the Paris specimens from Noël were identical with his own new species, *Hyla chalconota*, from Java! Schlegel comments upon the astounding distributional picture thus presented (1837: 24), and states that the species is labelled *Hyla septentrionalis* in the Paris Museum. This is the first appearance in print of the name *Hyla septentrionalis*, and because Schlegel couples it with a described species, his new *H. chalconota*, one might argue that *H. septentrionalis* becomes merely a substitute name for *H. chalconota*, under Article 25 of the International Rules. This is not, however, a clear case for routine application of the Rules, for there are several confusing complications. Schlegel's *chalconota* was a composite, including material of what are now called *Rana chalconota* Schlegel and *R. hosii* Boulenger (van Kampen, 1923: 215-217). The types of the name *H. chalconota* are unquestionably Schlegel's Javanese frogs, and, just as unquestionably, the Paris Noël examples were the types of Duméril and Bibron's manuscript name *H. septentrionalis*, as Schlegel knew it. Schlegel figured (described) *chalconota* from Javanese specimens and even he himself could not have held that the manuscript name *septentrionalis* was based on other than the Paris material. Schlegel merely gave an opinion that certain undescribed and unfigured frogs in the Paris Museum, supposedly from Norway, were identical with his types of *chalconota*. We are not even sure that Schlegel

ever saw the Paris frogs, and the erroneousness of his opinion on their identity was at any time open to proof by comparison of the types of the two names. These considerations plainly indicate that this case is one in which the Rules are insufficient and must be interpreted, and good sense dictates that we accept Stejneger's interpretation (1905). *H. septentrionalis* of Schlegel is, in this view, merely an incidental mention of a *nomen nudum* and has no effect upon a later publication of the name.<sup>7</sup>

To return to our narrative, Tschudi visited Paris while preparing his *Classification der Batrachier* and was given free access to the collections there by Duméril and Bibron. As with many other manuscript species names of these authors, Tschudi put *Hyla septentrionalis* into his own manuscript. The latter was published in 1838, and the account of *Hyla* (or *Dendrohyas*) *septentrionalis* which he gives is quoted above. As Stejneger says, the name is a *nomen nudum*. Not a single real character is given.

Subsequent to Tschudi's Paris visit, Duméril and Bibron received tree frogs from Cuba which they recognized as specifically identical with their "North Cape" *Hyla septentrionalis*. They erased the ill-fitting name and substituted for it the new name *Trachycephalus marmoratus*, in the manuscripts of both the Cuban report of Cocteau and Bibron and their *Érpétologie Générale*. The latter was published before the former, and is all that needs concern us.

In the eighth volume of the *Érpétologie* (1841: 358), *Trachycephalus marmoratus* is formally and well described from Cuban types sent by de la Sagra and Delaroche, and the North Cape confusion is explained. Unfortunately, however, the specific name *marmorata* is preoccupied in the genus *Hyla* (by Laurenti, 1768), and cannot be used for the Cuban frog when it is transferred to *Hyla*, where almost all modern herpetologists would place it.

It was a custom of Duméril and Bibron to quote in the synonymy their own previous manuscript or label names, especially in instances where other authors had utilized those names. Thus they quote not only the references of Schlegel and of Tschudi, and that in the then yet unpublished de la Sagra report, but also "*Hyla septentrionalis*. Nob. Mus. Par." That this must be considered a substitute name, quite as validly described and proposed and quite as available as the genus *Eleutherodactylus* in the same volume, is obvious. The formal "authorities" to be quoted for the name are therefore those who first coined and applied the name.

That the recognition of Duméril and Bibron as the describers of *H. septentrionalis* is more important than pedantic is also evident. If we had to recognize Boulenger's 1882 account as the original description, the well established name *septentrionalis* could not stand. In 1863, Cope (pp. 43-45) described two new Cuban frogs which have traditionally been placed in the synonymy of *septentrionalis*. Although Stejneger (1905: 330) greatly doubts that Cope's *Trachycephalus insulatus* is identical with *septentrionalis*, Barbour

<sup>7</sup> After the present paper had been submitted to the editors of *Copeia*, Mittleman (1950), on the basis of Schlegel's mention of *septentrionalis*, refers this name to the synonymy of *Rana chalconota* and resurrects the subsequent specific name *Hyla insulsa* for this hylid. Mittleman apparently did not realize that this case is open to interpretation, and his account does not take cognizance of several complicating factors. After full consideration of Mittleman's paper, my opinion is that his argument has technical soundness but that his premises are insufficient and his conclusion unacceptable, for reasons I have already given.

(1914: 238) and Barbour and Ramsden (1919: 94) say that both *T. insulsus* and *T. wrightii* are synonyms of *septentrionalis*. Stejneger does not even refer to *wrightii*, but one of these names of Cope's would unquestionably supersede *septentrionalis* of 1882 on account of priority. Recognition of Duméril and Bibron's authorship of *septentrionalis* therefore saves a name which, though ill-befitting a southerly frog, is of itself distinctive, euphonius, and above all, thoroughly entrenched in the literature.

Another point perhaps should be considered. The formal type locality of *Hyla septentrionalis* Duméril and Bibron, 1841, is not "North Cape (in error)" but Cuba. If *septentrionalis* of these authors is considered to be a substitute name for their *marmoratus*, it can possess no distinctive type specimens of its own, but is based upon exactly the same examples upon which *marmoratus* was based. These types were plainly stated to be from Cuba, although they included the "North Cape" ones. This point in regard to substitute names is a fine one and of no especial importance here, but some systematists do not understand it and occasionally it really is of importance.

The frog and its primary synonymy should therefore be cited as follows:

*Hyla septentrionalis* Duméril and Bibron, 1841

*Trachycephalus marmoratus* Duméril and Bibron, 1841: 538 (original description; type locality: Cuba, with no more definite locality cited; types in Muséum d'Histoire Naturelle, Paris; collectors, de la Sagra and Delaroche; name preoccupied in *Hyla* by *marmorata* Laurenti, 1768).

*Hyla septentrionalis* Duméril and Bibron, 1841: 538 (substitute name for *Trachycephalus marmoratus* Duméril and Bibron, 1841; same type locality; same type specimens; name in synonymy of *T. marmoratus*).—Boulenger, 1882: 368 (in part; Cuban specimens only).

*Trachycephalus insulsus* Cope, 1863: 43 (original description; type locality: Cuba; types in U.S. National Museum, nos. 6265-6; collector Felipe Poey).

*Trachycephalus wrightii* Cope, 1863: 45 (original description; type locality: vicinity of Guantánamo, Cuba; type in U.S. National Museum, no. 5174; collector, Charles Wright).

IV. SUMMARY

1. *Hyla septentrionalis* of Cuba, the Cayman Islands, the Isle of Pines, the Bahamas, and the Florida Keys, *H. dominicensis* of Hispaniola, and *H. brunnea* of Jamaica are three distinct non-intergrading species, differing in morphological characters and in habitat, even though they are closely related to each other. *H. brunnea* is by far the most distinctive of the three. In this connection, the *Rassenkreis* concept of species is discussed and reasons given for its rejection.

2. The Cuban and Florida Keys frog should be known binomially as *Hyla septentrionalis* and not trinomially as *Hyla septentrionalis septentrionalis* (or better, *Hyla dominicensis septentrionalis*), at least until subspecific differentiation within itself can be demonstrated.

3. The name *septentrionalis*, meaning essentially "of the north," was given in the mistaken idea that the original specimens (part but not the main series of the types) received at the Paris Museum were from North Cape, Norway.

4. If, as is usually done, the name *septentrionalis* is dated from Boulenger (1882), it is antedated by, and synonymous with, two specific names proposed by Cope in 1863.

5. The name *septentrionalis* cannot be dated from Boulenger (1882). It was validly proposed, in connection with an adequate description, by Duméril and Bibron in 1841, and the name must date from them. The proper quotation of the name therefore is *Hyla septentrionalis* Duméril and Bibron.

6. The main series of the type specimens of this species is in the Muséum d' Histoire Naturelle in Paris, and came from Cuba. The type locality of *septentrionalis* is therefore Cuba and cannot be cited as North Cape, even "in error."

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NATURAL HISTORY MUSEUM, STANFORD UNIVERSITY, CALIFORNIA.

## A New King Snake from Trans-Pecos Texas

By ALVIN FLURY

A SNAKE of the genus *Lampropeltis* which appears to be distinct from other described forms was found on a trip through Trans-Pecos Texas with Homer Phillips. Two subsequent short trips through the area and five weeks of field work 40 miles north of the point of capture by a University of Texas group have failed to supply any further specimens of the snake. This specimen is so different from any described form that I feel justified in naming a new species, based on the single specimen, which I wish to call

*Lampropeltis blairi*, sp. nov.

TYPE.—University of Texas Natural History Collection No. T4772, an adult male collected 8.8 miles west of Dryden, Terrell County, Texas, on June 3, 1948, by Homer Phillips and Alvin Flury. The specimen was found DOR on U. S. Highway 90.

DIAGNOSIS.—Dorsal scale rows 25 anteriorly; infralabials 11; subcaudals 63; annuli on body 14, the anteriormost red one about three times as wide as the others; gray annuli separated from black ones by narrow bands of white; red annuli in form of saddles completely enclosed ventrally by black; red scales not black tipped.

DESCRIPTION OF TYPE.—Head distinct from neck; general proportions of *doliatus* (Klauber, 1948) group; total length 885 mm.; tail length 138 mm.; tail divided by total length 0.156. Dorsal scale formula (Clark and Inger, 1942) as follows:

	141		154		—	
25	(5-6)	23	(5-6)	21	(—)	19
	(5-6)		(5-6)		(5-6)	
	144		155		211	

An old scar and a new cut on the left side opposite ventrals 214-224 obliterate the fusion of scale rows in that area. Ventrals 229; anal entire; subcaudals 63, in 2 rows. Dorsal scales with 2 apical pits.

Snout rounded; rostral about twice as wide as high with a low, wide notch below; internasals and prefrontals paired, symmetrical; nasals divided, nares lying equally in each scale; loreal single, small, twice as long as high; preoculars and supraoculars single; postoculars 3/3, lower one extending forward to median ventral point of orbit; temporals 3/3 in first row, lower more than twice as large as other two, 3/4 in second row and 4/5 in third; supralabials 8, 3rd and 4th entering orbit, 6th much smaller than 5th or 7th. Eye 4.3 mm. long. Mental small, triangular; infralabials 11, anterior pair meeting on midventral line and separating anterior one-third of first pair of chin shields; a very small scale on midventral line between posterior ends of anterior chin shields; 3 scale lengths between posterior end of chin shields and first ventral plate; 8 scale rows separate posterior chin shields from infralabials.

Dorsal pattern of alternating black-bordered red saddles and white-bordered gray saddles. Head shields black, mottled with gray; anterior 4 supralabials white, flecked with gray; a broad black band from eye to angle of

mouth; temporals, posterior part of head and sides of neck covered by first gray dorsal saddle.

Dark gray dorsal saddles 14 on body, one above anus and 3 on tail; range (including white border) 6-9 scale lengths (middorsal), average 7. Anterior-most saddle covering posterior part of head (7 scale lengths behind parietals); extending obliquely to 2nd scale row opposite 9th ventral. White borders narrow, irregular, about one-half scale wide middorsally; widening (at expense of black borders) to 2-3 scales on 1st to 3rd scale rows; white usually extending along 1st scale row and lateral edges of ventrals to enclose gray saddles.

Black bordered red saddles 14 on body and 3 on tail; posteriormost one completely black; next anterior one only flecked with red; average width of red saddles on body 6.7 scale lengths (middorsally), range 4-19 (4-9, aver. 5.8 if anteriormost saddle is discounted); red narrowing laterally, usually reaching 1st scale row for 1-4 scale lengths; red scales with irregular black flecks along edges; color of the apparently typical 7th red saddle seems to agree with Maerz and Paul's (1930) Plate 3, color A-11. Black borders 1-2 scales wide middorsally; narrowing to 1 scale on 1st and 2nd scale rows; uniting with black on ventrals to enclose red saddles.

Ventral surface with black borders of red saddles uniting laterally and forming a band 4-8 ventrals wide across belly; bands interrupted or mixed with white midventrally on anterior half of body. Irregular blotches of black and white opposite gray saddles; 2nd and 3rd of these blotches with lateral extensions of black invading gray saddles up to 5th scale row; 8th and 9th blotches with similar extensions reaching 1st scale row; blotches restricted to midventral region on tail. White borders of gray saddles usually 1-2 ventrals wide across belly but often mixed with black from irregular blotches.

**COMPARISONS.**—*Lampropeltis blairi* apparently belongs in the *mexicana* subgroup of Smith (1942) with *L. mexicana*, *leonis* and *alterna*. The enlarged nuchal saddle occurs in *mexicana* and *blairi* and the white border of the gray saddles is known for *alterna* (Jameson and Flury, 1948, and Mecham and Milstead, 1949) and is apparently present in *mexicana* (Blanchard, 1921, fig. 77). The high number of dorsal scales (25) and infralabials (11) occurs in *blairi* and *alterna*. The close relation of *blairi* to the *doliata* subgroup is shown by its similarity to *L. d. micropholis* of South America, which has the reduced number of rings, the red and gray ones of about the same width, the red rings sometimes closed by black on the belly and the reduced head pattern with the postocular black spot. From other species of the *mexicana* subgroup and from all forms of *L. doliata* except *micropholis*, *nelsoni* and *oligozona*, this new species may be distinguished by the low number of annuli on the body (14). The marked difference in width of the red and gray annuli separates *nelsoni* and *oligozona* from *blairi* while *micropholis* has fewer dorsal scales, caudals, labials and temporals. The four-color dorsal pattern, low number of annuli and the enlarged nuchal blotch are distinguishing characters of *Lampropeltis blairi*.

This species is named in honor of W. Frank Blair of the University of Texas, to whom I wish to express my thanks for his help, encouragement and patience during the past several years. Thanks are due also to Karl P. Schmidt for examining the type specimen and encouraging its description.

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DEPARTMENT OF ZOOLOGY, UNIVERSITY OF TEXAS, AUSTIN 12, TEXAS.

A Dimorphic Color Pattern of the Garter Snake *Thamnophis elegans vagrans* in the Puget Sound Region<sup>1</sup>

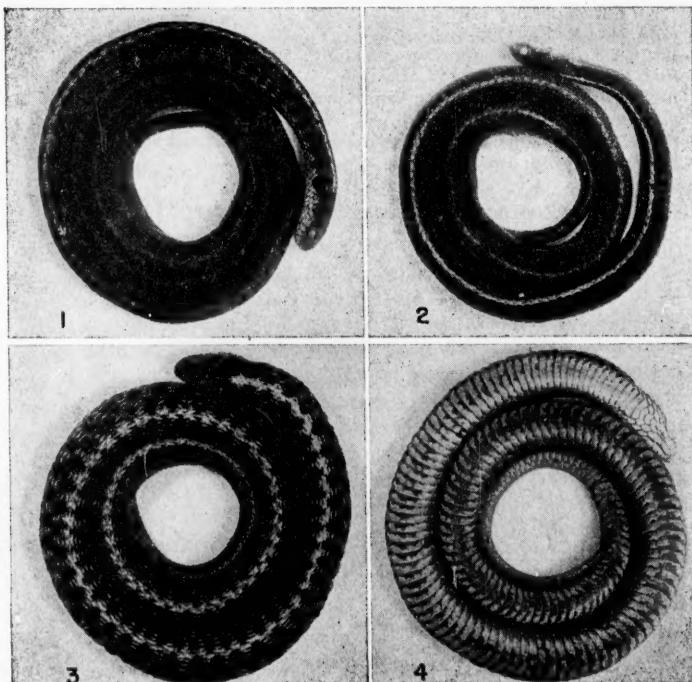
By WILLIAM B. HEBARD

DURING the examination and study of 177 field-collected specimens of *Thamnophis elegans vagrans* Baird and Girard from the Puget Sound region of Washington and during the analysis of 28 broods of young totaling 271 offspring, additional information was obtained on a dimorphic color pattern mentioned by Johnson (1947: 164). Johnson mentions the presence of spotted and non-spotted young in broods of *vagrans* but states that he had yet to secure an adult with this pattern. Fitch (1940: 17) in his paper on Pacific Coast garter snakes makes no mention of such an abnormal pattern.

Three adults in the above collection lack any trace of the double row of alternate black spots located in the dorsolateral area. The dorsal stripe is distinct, one and one-half scales wide and not invaded by any dark blotches. This non-spotted pattern is illustrated in Figure 2, of a gravid female, UW

<sup>1</sup>This study was made possible by a research fellowship granted by the Graduate Research Committee, Department of Zoology, University of Washington.

No. 1729, collected at Maple Valley, King County, Washington. On September 7, 1948, she gave birth to 18 young, of which 13 were spotted and 5 were non-spotted. The spotted young were normal in appearance. The non-spotted were normal in all characteristics except the absence of the double row of spots. The ground color was a solid brown similar to that between the spots of normal young. Figures 3 and 4 are photographs of a normal spotted female, UW No. 1850, collected at Kenmore, Washington, along the shore of Lake Washington.



Pattern dimorphism in *Thamnophis elegans vagrans*

Fig. 1, dorsal view of specimen from King Co., Washington, showing melanistic pattern. Fig. 2, another specimen from same locality showing non-spotted pattern. Fig. 3, dorsal view and Fig. 4, ventral view, of specimen from same locality with normal pattern.

There are occasional melanistic adults; for example, UW No. 1515, also from Kenmore (Fig. 1), in which the dorsolateral area appears almost solid black. Upon close examination, however, particularly in the neck region, the spotted pattern becomes apparent and the dorsal stripe is invaded by dark blotches. An adult non-spotted female, UW No. 1163, collected on Fidalgo Island near Anacortes, Skagit County, Washington, has a solid light brown ground color, though otherwise a typical *vagrans*. A non-spotted adult male from Huntingdon, B.C., was discovered in the collection of garter snakes

from the Museum of Zoology, University of British Columbia, loaned by Professor I. Cowan.

Four normally spotted gravid females gave birth to mixed broods of offspring. The ratios of spotted to non-spotted in the series of broods examined as well as in the broods mentioned by Johnson (1947: 164) are listed in Table I.

TABLE I  
RATIO OF SPOTTED TO NON-SPOTTED OFFSPRING IN BROODS OF *T. e. vagrans*

Cat No.	Female	Total young	Number spotted	Number non-spotted
U.W. # 1733 (spotted)		11	9	2
U.W. # 1639 (spotted)		9	8	1
U.W. # 1554 (spotted)		11	8	3
U.W. # 1860 (spotted)		11	9	2
U.W. # 1729 (non-spotted)		18	13	5
C.P.S. # 4451 (spotted)		9	8	1
C.P.S. # 3055 (spotted)		19	8	11

Sufficient evidence is not available for definite conclusions as to whether this is an example of simple Mendelian inheritance. Blanchard and Blanchard (1941) found that the character "melanism" in *Thamnophis sirtalis sirtalis* was due to a simple Mendelian recessive. Blanchard (1943) states that the irregular ratios of the inheritance of blackness were due to the spring mating being preceded by one in the fall. While fall copulation has been observed to occur in *T. ordinoides* in the Puget Sound region no direct observations of this phenomenon have been recorded for *vagrans*. Double mating may well be a factor in upsetting any tendency toward normal Mendelian ratios.

The variation in color pattern of *vagrans* in the Puget Sound region suggests a heterogeneous genetic condition that expresses itself phenotypically in a series of gradations from the normal spotted pattern to one of entirely different appearance.

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SCHOOL OF COMMERCE, ACCOUNTS, AND FINANCE, NEW YORK UNIVERSITY,  
WASHINGTON SQUARE, NEW YORK, N.Y.

## Resurrection of *Bufo occidentalis* Camerano and Remarks on the Status of the Toad *Bufo simus* Schmidt<sup>1</sup>

By I. LESTER FIPSCHEIN

**I**N 1857 Schmidt described *Bufo simus* from a collection of amphibians made by a commercial botanist, J. von Warszewiez. The locality for the collection was listed as "near Bocas del Toro, on the Chiriqui River, Panama." The type description first appeared in 1857 in a paper entitled, "Diagnosen neuer Froschen des Zoologischen Cabinets zu Krakau" and not under the reference and date (1858) universally accredited (Günther, 1858; Kellogg, 1932; Smith and Taylor, 1948).

Various authors have assigned the name *Bufo simus* to a toad from Mexico, and this designation has generally been accepted in modern works. Dugès (1869) was the first author to apply the name *Bufo intermedius* Günther (type locality, Ecuador) to this Mexican form. Camerano (1878) recorded and described three examples of a toad from Mexico as *Bufo intermedius* and listed *Bufo occidentalis*, a manuscript name of De Filippi, in the synonymy of this form. Cope (1879) also ascribed the name *intermedius* to Mexican specimens. In this paper he merely listed *intermedius* from Guanajuato but in addition described a new form from the same locality, *Bufo monksiae*. Judging from his description Cope characterized *monksiae* as a toad "without cranial crests," differing in this respect from *intermedius* which he previously placed (1862) in his new genus *Phrynooides*, based on a group of toads with longitudinal cranial ridges. Again, in 1885 and 1887, Cope mentioned the presence in Mexico of *intermedius* as a form distinct from *monksiae*. Günther (1901) was the first author to refer Mexican specimens to the species *simus*, and he concluded that Cope's *intermedius* (*nec* Günther) is essentially this species because of the character of a "hidden tympanum." Günther did, however, recognize the presence of a form in Mexico that is assignable to *intermedius*, having the tympanum not covered by skin. *Bufo monksiae* was also recognized by Günther, but qualified by a remark that it might merely represent the juvenile stage of some "crested" *Bufo*, such as *simus*. Neiden (1923) recognized all three species in Mexico and it was not until Kellogg's (1932) review of the Mexican Anura that the presently recognized position of this toad was so clarified. He synonymized both *intermedius* (as it pertains to Mexican specimens) and *monksiae* under the name *simus*, and essentially this allocation has been generally followed (Smith and Taylor, 1948). Schmidt and Shannon (1947) resurrected Cope's name and recorded Michoacan specimens as *B. monksiae*.

The extreme hiatus in range between Mexican localities of *B. simus* and that of the type locality in Panama, leads one to suspect the validity of this name as applicable to Mexican toads. Further, the unsubstantiated occurrence (other than the type series) of this species in Central America necessarily warrants a review concerning the validity of the locality assigned to the type series.

<sup>1</sup> Contribution from the Museum of Natural History, University of Illinois, Urbana, Illinois.

Dr. E. R. Dunn (*in litt.*) believes that there is some question concerning Panama as the correct collecting notation for this material of Warszewiez even though the locality designation is most exact. Rather it can be shown that this material may actually have been obtained in Ecuador and is possibly identifiable with *B. intermedius* of the Andean region or other toads from various South American localities. Warszewiez traveled extensively in Central America and northern South America as a commercial botanist. There is documentary evidence available from botanical sources that this collector, after reaching Bogotá from Panama, traveled westward through the Magdalena Valley, across the Central Andes and thence through the Cauca Valley and over the Western Andes to the Pacific where he boarded ship for Ecuador. The collections gathered during these journeys bear, in most cases, very specific localities but Dr. Dunn assures the writer that some botanists believe Warszewiez's localities are unreliable in a number of instances. Dr. Dunn also discovered, while reviewing the genus *Dendrobates*, that a species reported by Warszewiez from one locality has never again been taken at that point, but is common in another region along his route of travel.

It is difficult then to assign *B. simus*, as described by Schmidt from juvenile material, to any particular *Bufo*, considering the fact that the locality of the type series may be in error. They most assuredly cannot be identical with any Mexican *Bufo*. Dr. Dunn, who examined in 1929 the cotype material, which is now deposited in many European museums, forwarded his notes made on these specimens (Jagellonian University, Cracow, Poland, 5 specimens, lot No. 1029; Munich Museum 543/20; Hamburg Museum 1527; British Museum of Natural History No. 98.9.14.6; and an unnumbered specimen in the Naturhistorische Museum, Vienna, Austria, from the original cotype series; making a total of 9 specimens). The series is composed entirely of young examples, ranging in size from 15.5 mm. (BMNH) to 25 mm. (largest of the Cracow series). The parotoid is medium and circular; no cranial ridges are in evidence; toes  $\frac{1}{2}$  webbed; tympanum hidden; dorsolateral line of warts on body; light dorsolateral flecking, belly gray with pale flecking.

Schmidt states in the type description (from Warszewiez) that these specimens were found in great numbers along the banks of the Chiriquí River. The only species of *Bufo* otherwise known to occur commonly on the Panamanian Atlantic drainage are *haematiticus* Cope and *marinus* (Linnaeus). The enlarged parotoid of the latter deletes any consideration of this species, and the presence of a well defined tympanum in *haematiticus* certainly does not fit the description of *simus*. The oval parotoid and the presence of an enlarged series of dorsolateral tubercles together with a hidden tympanum would seem to cancel any consideration of known Mexican species of *Bufo* and possibly Günther's *B. intermedius* (1858: 140, pl. IX, fig. A.).

Considering then that the identity of *simus* presents such a problem and the type locality can be reasonably questioned, it would be well to regard *B. simus* Schmidt as a *nomen dubium* and to delete it from the synonymy of any species of *Bufo* until such time as evidence may be presented to the contrary.

There are two available names in literature that may be applied to the

Mexican forms formerly considered as *Bufo simus*: *B. monksiae* Cope (1879) and *B. occidentalis* Camerano (1878). The latter name is to be considered as the earliest junior synonym of *simus*. Cope named *monksiae* from a juvenile specimen (USNM No. 9896) collected by Dugès at Guanajuato. Upon examination it was found to agree in all respects with the young of the Mexican "*simus*." The type measured 33.3 mm. in length (not 23.5 mm. as reported by Kellogg) and, as is characteristic of the young of this species, it did not possess cranial crests. Evidently Cope, as indicated by his writings and specimens, considered this name as applicable to the young of the species; the adults (from the same locality and elsewhere) he designated as *intermedius* because of the presence of well defined cranial crests. Ives (1891) reported on 3 specimens from Zumpango, Mexico, and assigned them to *Bufo monksiae*. These specimens (Acad. Nat. Sci. Phila. nos. 2708-2710, as listed in the catalog) could not be located at the Museum at the time of the author's visit. However these most assuredly are, again, only juveniles (about 16 mm.) of the same species. Therefore, Cope's name *monksiae* is only a description of the young of this species and the type description does not define the adults. However, because of priority, this name can be considered as available but not as the correct name for the species.

*Bufo occidentalis* is a name used in the synonymy of *Bufo intermedius*, in a publication by Camerano. He states that this name, found in a museum manuscript of De Filippi, was applied to 3 specimens of a toad from Mexico. Camerano then described these Mexican "*intermedius*" (*idem ac occidentalis*) in detail.

The name *occidentalis* has been declared a *nomen nudum* by Kellogg but actually such is not the case. Camerano had listed this name as the only synonymous reference under *B. intermedius*. (Evidently he regarded this name as a "*nomen nudum*" since he mentioned specifically that it had never appeared in print but only in a manuscript of De Filippi.) However, an adequate citation of a manuscript name in the synonymy of a validly published species is to be regarded as constituting a "publication" with an "indication" and meets the requirements of Article 25 of the Rules of Nomenclature. According to Hemming (1950) the following wordings are to be incorporated into Article 25 of the Règles concerning the status of manuscript names. This decision was reached by the International Commission during the Paris (1948) meeting of the International Congress of Zoology: "Words to be inserted to make it clear that a manuscript name acquires standing under the Law of Priority when published in conditions which comply with the provisos to Article 25, and that the status of such a name is not affected by the question whether the author by whom it is published accepts it as an available name or sinks it as a synonym."

It is therefore established that *Bufo occidentalis* has been made valid inadvertently and without the specific intentions of the author. In the terminology of Blackwelder, Knight and Smith (1950), the published name *occidentalis* is an *acceptable* name; it is *occupied* since it meets the requirements of the Règles; it is a *correct* name, for this junior synonym is now *available* because the senior synonym, *B. simus*, has been declared a *nomen dubium* and is not available under the Règles. *Bufo occidentalis* Camerano then is a

name that should be applied to the form of *Bufo* in Mexico formerly designated as *Bufo simus* Schmidt, *Bufo intermedius* Günther or *Bufo monksiae* Cope. An acceptable re-description of *Bufo occidentalis* may be found in Kellogg (1932: 33-34) under the name of *B. simus*.

The re-designation and synonymy of this form is as follows:

*Bufo occidentalis* Camerano

1869 *Bufo intermedius* [nec Günther], Dugès, La Naturaleza, 1: 145 (Guanajuato, Mexico).  
1878 *Bufo occidentalis* Camerano, Atti. R. Accad. Sci. Torino, 14, Dec. 31; 887 (Mexico).  
1878 *Bufo intermedius* [nec Günther], Camerano, *ibid.*: 887 (Mexico).  
1879 *Bufo monksiae* Cope, Proc. Amer. Philos. Soc., 18 (104): 263 (Guanajuato, Mexico). (Read before Amer. Philos. Soc. June 20, published Aug. 11.)  
1879 *Bufo intermedius* [nec Günther], Cope, *ibid.*: 263 (Guanajuato, Mexico).  
1882 *Bufo monksiae* Cope, Boulenger, Cat. Batr. Sal. s. Ecaud. Brit. Mus.: 292.  
1882 *Bufo intermedius* [Günther, partim], Boulenger, *ibid.*: 307-308, fig.  
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TYPE LOCALITY.—Smith and Taylor (1950: 330) restricted the type locality of *Bufo occidentalis* to Guanajuato, Mexico. This is actually the first Mexican locality from which this species was reported (Dugès, 1869).

I wish to thank Dr. E. R. Dunn, Haverford College, for graciously forwarding much of the pertinent data on this problem, and Dr. H. M. Smith, University of Illinois, for his patient attention while the manuscript was being prepared.

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MUSEUM OF NATURAL HISTORY, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS.

## The Relative Efficiency of Two Types of Anti-Venom Sera in Neutralizing Cobra Venom

By DONALD B. VOETMAN

DURING the summer of 1945 I was stationed in Manila, P.I., with one of the United States Army Medical General Laboratories.<sup>1</sup> During the course of the summer two snake antivenins were received at the laboratory for testing against the venom of the Luzon cobra, *Naja naja philippensis*. According to Taylor " . . . These snakes are poisonous, and probably cause more deaths than any other snake in the Philippines. The subspecies is found very commonly in Luzon, . . ." Up to the time of the study two deaths from cobra bite had already been reported among U.S. military personnel stationed in or near Manila and an efficient antivenin was being sought for use by the military forces.

The two antivenins to be tested differed mainly in the fact that one was a locally prepared (Institute of Hygiene, University of the Philippines) antivenin, specific for the venom of the Philippine cobra. This antivenin was prepared in June, 1941, and packaged in a 10.0 cubic centimeter hermetically sealed vial. It had an expiration date of June, 1942. The serum was prepared from horses hyperimmunized against the venom of *N. n. philippensis*. The fact that this serum's expiration date was 1942 left its efficacy open to question, since liquid serum is considered unstable if stored at temperatures above 4° C. (39° F.).

The other antivenin received was an Indian polyvalent "Anti-snake venom serum" prepared from horses hyperimmunized against four snakes: Russell's viper, *Vipera russellii*; the saw-scaled viper, *Echis carinatus*; the common krait, *Bungarus caeruleus*; an Indian cobra, *Naja naja* (subsp.?). This serum was desiccated, lyophilized, and packaged with sufficient sterile, distilled water, included in a separate vial, to yield 10.0 cc. of reconstituted serum. Date of manufacture was July, 1945. The serum was prepared by the Haffkine Institute, Bombay, India. Both types of antivenin had been successfully used, but it was desired to check their relative efficiency against cobra venom, under controlled conditions.

Since there was only a small quantity of each type of serum available for testing purposes, it was decided to use white mice for laboratory animals and to run the experiment "in reverse," so to speak, in order to obtain the most information from a given lot of antivenin. This will be explained in more detail later.

**MINIMUM LETHAL DOSE.**—In order to determine the size of venom dosage that would consistently kill white mice in a workable period of time, the minimum lethal dose was first computed. Strong quotes Acton and Knowles as estimating that 15 milligrams of cobra venom is the minimum lethal dose for man. This is roughly equivalent to 5 milligrams of desiccated venom, the stock material from which dilutions were made. White mice averaging about 20 grams were to be used and an attempt was made to compute the minimum

<sup>1</sup> 19th Medical General Laboratory, Colonel Dwight M. Kuhns, commanding.

lethal dose for the mice on the basis of their total body weight only. The ratio of 20 grams to 150 pounds (weight of man arbitrarily selected) is approximately 1:3400. Five milligrams of desiccated venom divided by 3400 yields .0015 milligrams desiccated venom, the calculated m.l.d. for a white mouse weighing 20 grams. This amount of venom is present in a dose of .15 cc. (1:100,000) venom in normal saline. The dilutions were prepared accordingly and the calculated quantity was injected into the mice. This dosage failed to kill consistently and it was increased to .5 cc., which killed most of the mice in about two hours, and was considered to be the m.l.d.

**PREPARING DILUTIONS.**—The stock material used in preparing all dilutions was desiccated cobra venom secured from the Institute of Hygiene, University of the Philippines. The yellow crystals are stable and keep indefinitely if stored in a cool, dry place away from strong light.

Normal saline was used as a carrier, since the diluted venom was to be injected into living animals and side effects were undesirable. One-half per cent of phenol was added to the saline solution in order to suppress any possible bacterial growth, since it was necessary to store the diluted venom after preparation.

The method of preparing various dilutions of venom from crystals was as follows:

To 20 mg. desiccated venom was added 1.98 cc. phenolized normal saline. The saline was prepared by adding .5 cc. phenol to 99.5 cc. normal saline. This gave what we have designated as a 1:100 stock solution of cobra venom from which all further dilutions were prepared.

To prepare 1:1000 venom, .5 cc. (1:100) was added to 4.5 cc. phenolized saline. This yielded 5.0 cc. (1:1000) cobra venom.

To prepare 1:10,000 venom, .5 cc. (1:1000) was added to 4.5 cc. phenolized saline. This yielded 5.0 cc. (1:10,000), etc.

**STORAGE OF DILUTED VENOM.**—Diluted venom prepared in phenolized saline and stored in a refrigerator became slightly less toxic after three to four weeks' storage. New dilutions were prepared when control animals revealed that the poison was losing its strength.

**USE OF CONTROL ANIMALS.**—Various quantities of pure phenolized saline were administered subcutaneously and intraperitoneally with no ill effects to the mice. Each lot of prepared venom was tested on a new group of mice to check its potency. Every experiment with antivenin also included control mice that did not receive the help of the serum. This allowed direct comparison between mice receiving antivenin and those not receiving it. The mice in any one experiment all received the same amount and concentration of venom. The usual dose was .2 cc. venom (1:10,000), which killed the control mice in an average time of 51 minutes (average of 24 controls). This dosage is four times the minimum lethal dose, but was used in order to decrease the total experiment time to a more workable figure.

**SERUM SICKNESS.**—In order to detect any unfavorable reactions of the mice to the serum, and in order to conserve the antivenin as much as possible, it was decided to administer the antivenin first and the venom later. The experimental figures might have been altered or even invalidated if serum

sickness had resulted following the administration of the antivenin to the mice. None of the mice injected with these anti-sera showed any unfavorable reaction to them, however, and the cobra venom was administered 16 hours later.

*Some persons are hypersensitive to horse serum and the injection of snake antivenin in such subjects may produce severe serum sickness or even acute anaphylaxis. The manufacturer of the Indian serum warned against the use of their product in persons who had ever received injections of horse anti-sera previously, unless the patient was first skin tested and desensitized if necessary.*

**ADMINISTRATION AND RESULTS.**—Intraperitoneal injection of the antivenin seemed to be the most reliable and accurate method of administration in mice. Slow intravenous injection into the sub-caudal vein was also attempted, but usually a portion of the serum was lost or was introduced subcutaneously and accurate quantitative work was difficult. Larger animals could be given intramuscular and intravenous injections more readily.

The mice were separated into three groups the afternoon before they were to be given the cobra poison. One group was kept for controls, the second group was given .2 cc. of the Indian polyvalent anti-snake venom serum, and the third lot was given .2 cc. of the Philippine cobra antivenin, both antivenins being administered intraperitoneally. The following morning, 16 hours later, all three groups received .2 cc. (1:10,000) cobra venom subcutaneously. The 24 controls died in an average time of 51 minutes. In lot two, 19 mice had been given the Indian polyvalent serum. The average weight of these mice was 23 grams. There were no recoveries from this group, although the death time averaged 101 minutes. The third group of 30 mice had been given the Philippine cobra antivenin. The average weight of the mice in this group was 18 grams. Six recoveries were secured and the remaining 24 mice died in an average time of 136 minutes after venom administration. *Although this lot of mice averaged about 20 per cent lighter than the mice which received the Indian anti-snake serum, their average survival time was 35 minutes longer, in addition to 6 recoveries obtained, against none for lot two.*

In succeeding experiments, the time data for which are not available, the mice were given antivenin treatment at varying periods of time following administration of the cobra venom. A much higher percentage of recoveries was secured with both antivenins in these tests, but the recovery percentage was always greater with the Philippine cobra antivenin than with the polyvalent type material. None of the control mice (no antivenin) ever survived .2 cc. of cobra venom (1:10,000). Antivenin administration immediately following venom administration gave the best results with both types of anti-sera.

**CONCLUSIONS.**—In view of the fact that the mice received no treatment but antivenin injections, the degree of protection offered by either of the two anti-sera tested was considerable. However, the more pronounced effects of the Philippine antivenin would certainly indicate the use, if available, of a serum prepared specifically for cobras, rather than a polyvalent type of serum less specific in its action against the highly neurotoxic qualities of cobra venom. To secure recoveries when using the polyvalent type of antivenin, it would appear that larger quantities of the serum should be given the victim of cobra bite than is necessary when the univalent cobra antivenin is used.

Storage of liquid antivenin in hermetically sealed vials is possible for long

periods of time (at least four years) without serious deterioration of the product. Storage in a cool, dark place is recommended.

Serum sickness does not result from the administration of these antivenins to laboratory mice, providing the mice have not been previously sensitized. Persons sensitive to horse serum products should be desensitized, however, or anaphylaxis may result.

Either of these types of antivenins will materially assist in neutralizing any cobra venom already absorbed into the blood stream. When supplemented with the proper first aid measures for snake bite victims, there is a fair to good chance of recovery from the bite of the Philippine cobra. The poison is very rapid in its action, however, and the chances for recovery decrease as the time interval between snakebite and antivenin administration increases.

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U. S. FISH AND WILDLIFE SERVICE, BISMARCK, NORTH DAKOTA.

### Herpetological Notes

A THIRD LOCALITY FOR THE RINGED SALAMANDER, *AMBYSTOMA ANNULATUM*.—Dr. Walter M. Scruggs, of Eastern Illinois State College, recently called my attention to a specimen of *Ambystoma annulatum* Cope collected 5 miles east of Camdenton, Camden County, Missouri, near Lake of the Ozarks, May 14, 1948, by his zoology field group. The locality data are unquestionable since Dr. Scruggs was present when the specimen was captured. Although this strikingly marked salamander has been known since 1886, Bishop (1943, *Handbook of Salamanders*: 115) indicates the range as "Vicinity of Hot Springs, Arkansas, and Stone County, Missouri." A check through the recent literature and with Dr. Bishop (*in litt.*) has revealed no additional locality records. The locality cited is the third known for the species and extends the known range approximately 100 miles northward.

This specimen (deposited in the museum at Eastern Illinois State College) is 73 mm. from snout to vent with a total length of 167 mm. There are 13 costal grooves, 12 of which completely traverse the belly; 2 costal folds between the adpressed limbs; and 14 white rings crossing the back. The specimen is somewhat at variance with the original description and a specimen from Stone County, Missouri, in having a well developed anterior gular fold in addition to the posterior fold.—PHILIP W. SMITH, *Illinois Natural History Survey, Urbana, Illinois*.

POPULATION DENSITY OF SNAKES IN AN AREA NEAR CHICAGO.<sup>1</sup>—In a study on a population of snakes in the Chicago area (Seibert and Hagen, 1947, COPEIA, (1): 6-22) a total of 298 *Thamnophis radix*, 78 *Opheodrys vernalis*, and 7 *Thamnophis sirtalis* were marked and released at the point of capture at weekly intervals from May 20 to November 4. During this period, 13.8 per cent of *T. radix*, 15.4 per cent of *O. vernalis*, and 0 per cent of *T. sirtalis* were recovered. This area, as described in that paper, comprised 3.2 acres (13043 m<sup>2</sup>).

Some attempts were made to determine the probable total population of snakes in that area but the results were not published. Our hesitancy was due to the puzzling and seemingly contradictory nature of our recovery data. First, the accumulated percentages of recoveries of *T. radix* rose during May, June, July, and August as would be expected from the increasing number of individuals being marked but after that period the recoveries fell below expectancy. Green snake recoveries increased only to the end of July and decreased appreciably thereafter. We concluded that the population was fluctuating either by the emigration of marked individuals or an influx of new ones or both. However, our recoveries tended to show that a) the snakes did not wander to any great extent and b) some of the individuals marked early in the season were still present on the area until September and October. Evidence a) is not consistent with mass migration nor is b) consistent with any replacement hypothesis. Finally, as the season progressed, the number of new snakes marked each week decreased in a logarithmic fashion. Obviously our sampling was not representative of the true state of activities within the snake population.

Nonetheless the writer feels that some sort of quantitative estimate, even though not entirely accurate may sometimes be of greater value than no figure at all. The following data are offered in the hope that they will at least provide information that can be used for comparative purposes.

Each week in which at least one recovery was obtained, an estimate of the population was derived by use of the so-called Lincoln Index, whereby the ratio of recoveries in a sample is to the total marked as the number sampled is to the total population. As has been brought out on many occasions, this assumption is valid provided that marked individuals distribute freely in the population and that the subsequent sampling is strictly random. Again it must be emphasized that our data do not indicate such to have occurred. By this method, the total population of *T. radix* comes out to 1152, and that of *O. vernalis*, 142, giving an average density of 360 and 44 snakes per acre.

Recently Hayne (1949, Jour. Mammalogy, 30: 399-411) has proposed a modification of the Lincoln Index method which utilizes the increase in the proportion marked at each successive catch. Hayne describes the method simply, "As marking of the animals progresses, the proportion of the population which is marked will increase. Marking one additional animal will cause the proportion marked to increase by a certain amount, and this increase is inversely proportional to the population number. After finding the average amount by which the marking of one further animal changes the proportion of the population which is marked, it is easy to estimate the population."

Using this method the population of *T. radix* comes out to be 1093 and that of *O. vernalis*, 237, the respective densities being 342 and 74 snakes per acre. With regard to the garter snakes the agreement in the two methods is quite close and if the figure is anywhere near correct, it turns out that approximately one-third of the population was marked. The second method gives a much greater population estimate for green snakes than does the former. Probably the higher value is closer to actuality since this would also indicate that one-third of the green snake population had been marked; one would not expect to find a greater proportion of the green snake population than was obtained for garter snakes since the former species is more prone to remain out in the open and hence more easily overlooked.

We found the mortality rate in garter snakes to be around 20 per cent. If the population and the rate remain constant from year to year and assuming further that one-fourth of the mortality occurs during the period of hibernation, then the remaining 15 per cent would have occurred during the period of study. Since our study lasted 21 weeks, the weekly reduction in snakes would amount to 0.71 per cent. This factor need not enter into the calculation provided that unmarked snakes die at the same rate as the

<sup>1</sup> Contribution No. 46 from the Department of Zoology, Ohio University.

marked. There is the possibility that mortality may have been greater among marked individuals, a condition that would exaggerate the total population estimate.—HENRI C. SEBERT, Department of Zoology, Ohio University, Athens, Ohio.

NOTES ON *HOLBROOKIA TEXANA* IN TEXAS.—The greater earless lizard, *Holbrookia texana* (Troschel), is abundant on the limestone and granite exposures of Central Texas. Incidental observations on populations of this lizard near Kerrville, Texas, during the summer of 1949 provide some information on the life history.

Lizards were collected by shooting with rubber bands and were preserved, marked and released, or retained for observation. Body lengths were recorded as the length from the anterior lip of the vent to the tip of the nose. All individuals not released were examined by dissection.

The limestone ledges along streams apparently provide an optimum habitat for these lizards. Each adult lizard appears to establish a home range, selecting a series of boulders or crevices as retreats. An individual disturbed from one site darts directly to another and returns to the original site when again disturbed. This was a common occurrence and the behavior pattern was sufficiently stereotyped to be of use to a collector. One lizard, difficult to capture, made six trips between the same two rocks although many other places of concealment were available.

Courtship behavior was observed repeatedly during June and July but no complete courtship sequence leading to copulation was recorded. The egg-laying season is prolonged. Of 26 females (56 per cent of the females collected) containing oviductal eggs, 7 were collected June 19-21, 7 on June 26, 2 on July 12, 2 on August 8, and 8 on August 16. The females deposit several broods per season. All the females containing oviductal eggs in June and early July had oocytes measuring 5-8 mm. in diameter. Females taken in August did not contain such oocytes. The data suggest a reduction in the number of eggs as successive broods are deposited. Of the 7 females collected June 19-21, 4 contained 7 eggs, 2 had 5, and 1 had 6 eggs; of the 7 collected June 26, 3 contained 6 eggs, 2 had 7 and 2 had 8. These numbers are in marked contrast with those recorded from females taken in August. Of 10 females examined 4 had 5 eggs, 2 had 4, and 4 had 2 eggs. None of the females containing 2-4 eggs had enlarged oocytes.

No nests were found although areas supporting large populations were searched by moving boulders and enlarging crevices with a crowbar. Eggs of other lizards (*Crotaphytus*, *Sceloporus*) were found, but not those of *Holbrookia*. The eggs are probably deposited deep in soil accumulated in crevices.

One group of eggs, dissected from a female June 26 and retained in moist sphagnum moss at room temperature, hatched August 14, an incubation period of 50 days. The 5 hatchlings were 2.03-2.05 cm. in body length when one day old.

The young grow rapidly and attain sexual maturity during the first year of life. The collections in June (14 males and 20 females) included no immature individuals and none were observed in the field. The smallest female collected in June measured 6.4 cm. in body length; the smallest male 5.27 cm. The first juveniles were observed in the field during the first week in July. Four juveniles collected July 11 measured 2.17, 2.38, 2.63 and 3.80 cm. in body length respectively. Juveniles (14) collected August 8 had a greater size range, 2.53-5.14 cm.

A sample of 35 juveniles and adults taken on August 16 could not be divided into size groups. The juvenile males varied in body length 3.62-5.42 cm.; the adult males 6.87-7.32 cm. The juvenile females varied in body length 3.03-5.17 cm.; the adult females 5.62-7.02 cm. The juveniles of both sexes exhibited a rather uniform size gradient. The largest male collected during the summer had a body length of 7.9 cm.; the largest female 7.5 cm.; the smallest adult male was 5.27 cm. in body length; the smallest adult female 5.52 cm.

A striking correlation between the color of the skin and the predominant rock color was noted by Mr. Alexander Sprunt, Jr. An area of red granite known as Enchanted Rock, in Llano County, Texas, supported these lizards in great abundance. All of the individuals taken from this granite region were rusty-brown in color in strong contrast with the light grey color of those from the limestone areas. The reddish lizards did not change color when retained in captivity.—FRED R. CAGLE, Tulane University, New Orleans, Louisiana.

THE PROBLEM OF THE NATURAL RANGE OF A SPECIES.—In a recent issue of *COPEIA* (1949: 233) Professor William B. Davis discusses the capture of a specimen of *Opheodrys vernalis blanchardi* in Austin County, Texas, and suggests that the state be considered within the range of the species. In doing so he brings up a more general question that requires critical attention. In this modern age, with its rapid mass transportation of persons and vehicles, and with its many keepers of pet turtles and snakes, to what extent does the capture of a single specimen actually contribute towards an understanding of the natural range of a species? There are two very different ends that may be sought in expressions of animal distribution. In one case, an attempt at a definition of the natural range of a species is made, while in the other, of much less zoogeographical significance, a mere list of all localities at which a specimen of the species has been taken is compiled. The ornithologists have long recognized the complexity of this problem in their study of avian distribution.

The serious student of animal distribution is concerned primarily with the natural range of an animal and those ecological features that exist throughout the range and in adjacent areas. He is less interested, from the distributional point of view, in those areas in which the species may have become established after chance or purposeful introduction by man. (Of course, much of the animal's biology may be learned from established individuals, but that is beside the point under consideration.) And, accordingly, he normally pays little attention to instances in which a single individual animal is found in an area remote from its natural range. In fact, about the only attention such records receive from zoogeographers is a statement that attempts to justify their exclusion from further consideration.

Professor Davis was, naturally, impressed with his capture of the smooth green snake and feels that it lends weight to the other Texas coastal records. I have no additional information beyond that already given (1941, *Misc. Publ. Mus. Zool., Univ. Mich.*, 50: 15-16) for the alleged Texas records except the one for Bosque County. In Malnate's map of the distribution of *Rhadinaea flavilata* (1939, *Zoologica*, 24(3): 360), I may point out that the species is restricted to a very narrow coastal belt from eastern Louisiana eastward and northward into North Carolina, except for a single specimen from Bosque County, Texas. All specimens (55 were examined altogether) were from localities at 120 feet elevation or less. Again, this does not include the same Bosque County specimen which was collected at 620 feet. This individual snake was allegedly taken by the same workers who collected the questionable Bosque County *Opheodrys*. It has been suggested to me, by a responsible authority at the Carnegie Museum where both of these specimens have been deposited, that these men kept all their small snakes in one jar, to save space, and that the locality label (Clifton, Bosque County, Texas) represents a place of residence of some or all of the collectors where most, perhaps, but certainly not all, of their specimens originated. So, not only is the Bosque County record of *Opheodrys vernalis* rendered even more doubtful, but it seems, in addition, that *Rhadinaea flavilata* should be deleted from the Texas list until suitable data have accumulated to demonstrate that Texas is part of its natural range.

A second point that Professor Davis offers in support of his contention deserves more serious consideration. Here he compares the hiatus in the territory between the locality of his specimen in coastal plain Texas, and the nearest unquestioned records in New Mexico, with the situation in *Rana a. areolata*, in which there is a gap between the records from the same general region of coastal plain Texas and the other batch of records from southeastern Oklahoma, southwestern Arkansas, and northwestern Louisiana. In Professor Davis' brief article, the following relevant points about the comparison were not mentioned. 1. The two groups of *areolata* records both lie in the Gulf Coastal Plain and this same general type of country is continuous between the two. Davis' specimen of *Opheodrys* came from the Gulf Coastal Plain, while the New Mexican specimens are from the Pecos Valley and the Southern Rocky Mountains, and between the two areas lie the Edwards Plateau and Central Texas (both subdivisions of the Great Plains). 2. In the frogs, the hiatus is about 250 miles airline; in the snakes, about 500 miles and, moreover, the reviewers of the gopher frogs indicated that their list was not a complete tabulation (Goin and Netting, 1940, *Ann. Carn. Mus.*, 38: 156). 3. *Rana areolata* is essentially a lowland form and the area under discussion in Texas seems perfectly congruous with such a distribution.

*Ophiodrys vernalis* is essentially an upland species (based upon over 800 specimens in collections) with only a few scattered dubious coastal plain records. The point of the comparison, as Professor Davis would have it, is that since the hiatus in the range of *aerolata* is not considered significant, we should, likewise, ignore the hiatus in *Ophiodrys*. The argument fails because the two situations, when analyzed, are not comparable.

The question now remains, does the smooth green snake occur naturally in Texas? I do not doubt that Davis collected a smooth green snake in Austin County, Texas, nor that Burt collected one near Waxahachie, Texas, in 1931. I submit, however, that these records, and others like them, are not an indication that there is a natural population of the species in coastal plain Texas. Nor do I deny that the species *may* occur naturally in Texas; there is as yet no acceptable evidence for its occurrence there, but one would not be surprised if it were to be found in western Texas or in the panhandle. But it must be remembered that the matter of greater biological import is to interpret the natural distribution of an animal rather than to add, or delete, a species from a state list.

In summary, the weight of evidence, both zoological and non-zoological, seems to indicate that neither *Ophiodrys vernalis* nor *Rhadinaea flavilata* occurs naturally in Texas. The natural range of an animal does not necessarily include all points at which it has been captured; some of these places of collection, for reasons known or surmised, may occasionally lie outside the natural range of the species. It is an investigator's responsibility to be critical in his evaluation of such records.—ARNOLD B. GROBMAN, Department of Biology, University of Florida, Gainesville, Florida.

A CASE OF TWIN HATCHING IN THE ROUGH GREEN SNAKE.—There appears to be a dearth of information in regard to twinning in snakes. Bert Cunningham (Axial bifurcation in serpents, Duke University Press, 1937) cites a number of reports by other authors of double and quadruple embryonic discs (cf. Wetzel, 1900: 70, pl. 12) and double embryos (cf. Braun, 1876: 6, pl. 12, and Cligny, 1897: 6). All but the latter of these reports, which was not specified, were of the snake *Natrix natrix* (= *Tropidonotus natrix*), and the references were included in Cunningham's work regardless of the fact that they were not cases of axial duplication.

An adult female *Ophiodrys aestivus* Linnaeus, measuring 642 mm. in total length, was collected 6 mi. N.W. of Decatur, Wise County, Texas, on June 10, 1949. The snake was placed in a glass-fronted terrarium with a one-inch layer of sand covering the floor. On the morning of the following June 19, 6 eggs were found deposited in a clutch near the center of the cage. The eggs were adhesive, smooth, and cream-colored, with length and width measurements as follows, in millimeters: 22 x 8.5, 25 x 10, 25 x 10, 26 x 9.5, 27 x 11, and 29 x 10. The entire clutch was placed to incubate at room temperature in a petri dish surrounded by damp paper toweling, as recommended by C. B. Perkins (Herpetologica, 4: 184). The smallest egg differed from the others in being brownish-yellow, comparatively hard, and irregular in shape. This egg was opened on June 27 and a pasty material was found inside. No embryo could be detected.

On July 23 and 24 the 5 remaining eggs hatched, but with the unexpected total of 6 hatching snakes. The brood consisted of 4 females and 2 males. Total length and tail length measurements are as follows, in millimeters: males, 190.5/71, 190.5/68.5; females, 210/67.5, 200/67.5, 140.5/49, 151/51. The latter two measurements are those of the twin snakes. Both of these were monocular, each lacking a left eye. Except for this abnormality and being significantly smaller, the twins were similar to the rest of the brood. It is thought that the twin snakes emerged from the largest egg, but as hatching of all of the snakes was not observed, this surmise cannot be confirmed. No egg-teeth were observable four days after hatching.

Whether this phenomenon represents identical or fraternal twinning is open to conjecture, as it would have been necessary to ascertain the presence of a single or double yolk. The duplication of the abnormality and sex would imply identical twinning.

These specimens are deposited in the Dallas Aquarium preserved collection. The mother snake is No. A508 and the hatchlings are Nos. A523-8.—LAWRENCE CURTIS, 4145 Normandy Ave., Dallas 5, Texas.

STATUS OF GARTER SNAKES IN A FOREST-PRairie ECOTONE IN SOUTHERN MINNESOTA.—With the aid of Howard Schriever, a student at the State Teachers College in Mankato, Minnesota, I made a mid-summer census of the garter snake population of a relatively undisturbed 4-acre plot within the city limits of Mankato. The census was primarily aimed at determining the relative status of the various forms of garter snakes in the ecotone between forest and prairie in Blue Earth County. The study area consists of a peninsula of a plateau at the south rim of the Minnesota River Valley. It is covered by scattered red oak (*Quercus borealis* Michaux) with some hard maple (*Acer saccharum* Marshall) and a ground cover of herbs and scattered shrubs, which include both prairie and deciduous forest species. The prairie grasses *Andropogon Gerardi* Vitman and *Bouteloua curtipendula* (Michaux) Torrey are present but not abundant. Other species with prairie or oak savannah affinities include *Comandra Richardiana* Fernald, *Antennaria* spp., *Ceanothus americanus* Linnaeus, *Lespedeza capitata* Michaux, and *Lathyrus ochroleucus* Hooker. These species are most abundant along the south rim of the peninsula but some are scattered through the more open sites. They are definitely subordinate to the deciduous forest species, however, and all of the steep slopes of the northwest-pointing peninsula are heavily wooded with a climax maple-basswood forest in which the red oak shares dominance along the rim and on the south slope. The numerous herbs of this association include *Aralia nudicaulis* Linnaeus, *Viola* spp., *Erythronium albidum* Nuttall, *Triosteum perfoliatum* Linnaeus, *Phlox divaricata* Linnaeus, *Uvularia grandiflora* Smith, etc.

The area was under observation throughout the summer of 1948 but snake collections were made only during the last week in July and the first two weeks in August. At least one trip was made through the area each day except Sunday. Occasionally morning and afternoon trips were made. Each specimen was identified, sexed, measured, marked by clipping tail scutes, and released. Sufficient specimens were captured to give useful data on the relative abundance of the forms present, but too few marked specimens were recaptured to give accurate data on population size or movements.

Two species of *Thamnophis* occur in this region, the plains garter snake (*Thamnophis radix*) and various color phases of the common garter snake (*Thamnophis sirtalis*). Of the 34 different individuals captured 9 were *T. radix* and 25 were *T. sirtalis*. It is apparent that while the latter was preponderant both species thrive in this ecotone. Only 3 of the marked individuals were retaken, but since all were captured during the last three days and since only 2 new specimens were taken in this time these data may indicate approximate population levels. A minimum average of 8 + garter snakes per acre occurred in the study area at some time during the three-week period in July and August just prior to the time of birth of young, when the population is at its low ebb. The small number of specimens recaptured may indicate a large range, or that these snakes are not strongly bound to a restricted territory, or simply inadequate sampling of a large but well concealed population. The largest number taken on a single two-hour trip was 8 and on two trips none were found. The average number per trip was greater during the first week than during the last. No young of the season were captured. Three gravid females were taken into the laboratory during the last week and gave birth to young within the following three weeks. A plains garter snake 63 cm. long gave birth to 16 young that averaged approximately 16 cm. long.

*Thamnophis sirtalis* is represented in the Mankato region by an intergradient population that includes individuals typical of *T. s. sirtalis* as well as of *T. s. parietalis*, with a rather complete series of intergrades between them. Of the 25 specimens of this species captured 8 were clearly without red, 6 had distinctly red skin between the scales, and 11 were intergradient in varying degree. That the fauna as well as the flora of this habitat is ecotonal in nature is well illustrated by these subspecies. Breckenridge (1944, Reptiles and Amphibians of Minnesota: 147) states that: "Typical common garter snakes . . . are definitely limited to wooded habitats in Minnesota . . . Specimens showing red between the scales occur throughout most of the state—typical *T. s. parietalis* occur largely in the prairie portions of the state." The above author cites no records of *T. s. sirtalis* for the "big bend" of the Minnesota Valley.

Although no quantitative data are available, the fall and spring populations in the study area are known to be much larger. Both species have been observed emerging in groups in April from burrows in which they were undoubtedly hibernating. On cold

sunny mornings in spring and less commonly in fall groups of 3 to 6 or more were often encountered closely intertwined in open situations. This curious habit may be associated with the hibernation instinct. Apparently low temperatures set off a gregarious urge in these snakes. This may account for the large numbers of specimens found in some dens even though other adequate retreats are unused. A possible benefit in heat conservation seems doubtful for small groups at the surface of the ground although this could be a factor in dens. The large numbers observed in spring and fall as contrasted with the low summer population indicates migration of many of the snakes from the valleys to the upland dens in fall and their redispersal in spring. As many as 38 garter snakes were counted in the study area during a single warm sunny afternoon on May 2, 1948.

In both species of garter snakes the sex ratio showed a preponderance of females. Of the 9 plains garter snakes 6 were females and 3 were males. The length ranged from 45 to 65 cm. Of the 25 specimens of *T. sirtalis* 17 were females and 8 were males. The length of these specimens ranged from 43 to 73 cm.

Several other species of snakes were encountered in the study area and since they have not previously been reported from Blue Earth County I list them. The fox snake (*Elaphe vulpina*) and the bull snake (*Pituophis sayi*) were seen only in early spring as they emerged from dens. The smooth green snake (*Opheodrys vernalis*) and the milk snake (*Lampropeltis doliata*) were noted at various times during the summer.—DON L. JACOBS, Department of Botany, University of Georgia, Athens, Georgia.

**SOME COLD-BLOODED VERTEBRATES OF THE OKLAHOMA PANHANDLE.**—The summer Biology Field Tour class of the University of Tulsa spent the period of June 18-21, 1949, in the Oklahoma Panhandle. In the course of general ecological observations a number of cold-blooded vertebrates were observed or collected. In view of the relative paucity of knowledge of the life of this part of the state, a brief note seems worthwhile.

A fish collection was made from the shallow, sandy North Canadian River some 5 miles northeast of Guymon. *Notropis girardi* was present in large numbers. Less plentiful but common were *Plancterus kansae*, *Pimephales promelas confertus*, *Hybognathus placita*, and *Extrarius aestivalis tetraneurus*. Also represented in the collection were *Notropis lutrensis*, *N. deliciosus missouriensis*, *Ameiurus melas*, and *Lepomis cyanellus*.

Near Kenton the shallow Cimarron River is largely sandy, but with occasional rocky riffles. At 2 P.M. the water temperature was checked at 84° F. The fish fauna was found to be quite similar to that of the North Canadian at Guymon, but with *Extrarius aestivalis tetraneurus* and *Ameiurus melas* absent, and with *Campostoma anomalum plumbeum* the only addition. It is of interest that here *Notropis deliciosus missouriensis* was very common (breeding adults) while only a single specimen of *N. girardi* was taken.

Daytime collection and observation of land vertebrates in the broken mesa and canyon area north of Kenton revealed *Crotalus v. viridis*, *Eumeces obsoletus*, *Sceloporus undulatus elongatus*, and *Phrynosoma cornutum*. Night collecting added *Rana pipiens*, *Bufo woodhousii*, and *Tropidoclonion lineatum* from the flood plain of the Cimarron.

The small stream that flows in Tesequite Canyon some 2 miles east of Kenton is considerably cooler than the Cimarron. It has many pools of 4-8 feet depth and varies from muddy to sandy to rocky. But four species of fish were collected—*Plancterus kansae*, *Carassius auratus*, *Pimephales promelas confertus*, and *Campostoma anomalum plumbeum*. *Campostoma* was extremely common. Larvae of *Acris crepitans* were collected with the fish. After dark *Rana catesbeiana* and *Bufo punctatus* were heard calling along the creek.

A small pond some 5 miles east of Kenton yielded a single *Kinosternon flavescens flavescens* and many large larvae of *Ambystoma tigrinum mavortium*. Nearby were collected *Holbrookia m. maculata* and *Cnemidophorus grahamii* (Smith, 1949, Bull. Chicago Acad. Sciences, 8 (13): 277-284, considers this species to be properly called *C. tesselatus*).

I am indebted to Dr. Hobart M. Smith for identification of certain of the lizards and to Dr. George A. Moore for aid in identification of the fishes.—ALBERT P. BLAIR, Department of Zoology, University of Tulsa, Tulsa, Oklahoma.

A NEW SOUTHEASTERN RECORD FOR THE COAL SKINK.—The discontinuous distribution of *Eumeces anthracinus* (Baird) makes each new record of its occurrence of interest in an attempt to gain a true picture of its range. Only a single specimen (USNM 75291) has been recorded from Alabama since Cope (1880, Bull. U. S. Nat. Mus., 17: 19) described one of these lizards from Mobile (Mobile County) as *Eumeces pluvialis*.

A small colony of *E. anthracinus* was discovered at Harris Lake, Tuscaloosa County, Alabama, in the summer of 1938 by Thomas C. Albright, Jr., Lee Bidgood, Jr., J. Garland Wood, Jr., and myself. This population appears to be restricted to the northwest side of Harris Lake, an artificial reservoir about 8 miles northeast of Tuscaloosa in the Valley-Ridge Province about 8 miles from the Coastal Plain. Most of the skinks were found near the water's edge under pieces of shale, which litter the ground. Several specimens were collected at this time, but none was permanently preserved.

Since no specimens from northern Alabama had been recorded in the literature, I made another trip to this locality on June 10, 1947, accompanied by Joseph T. Allen, and Peggy P. Dowling. A single female *E. anthracinus* was collected from under a piece of cardboard at the shoreline. Another female guarding a clutch of 6 eggs under a piece of shale escaped, and one of the eggs was broken in the attempted capture. The other 5 eggs were taken to the laboratories of the Biology Department of the University of Florida.

Two of the eggs were placed in a small flower pot as used by Goin (1947, Univ. Fla. Biol. Sci. Ser., 4 (2): 2) for eggs of *Eleutherodactylus*; the remaining 3 were left in the damp moss in which they were found. The latter were soon covered with mold that killed the embryos, but those in the flower pot hatched on July 4. One of these was preserved on the same day (UMMZ 98633).

The adult female and the young specimen have the following characters in common: postnasal absent; postmentals 1; scale rows at midbody 26; upper labials 7; lower labials 6. The adult (UMMZ 98631) has 50 dorsals and 51 scales between the anterior chin-shields and the preanals; the young one has corresponding numbers of 48 and 50. It is notable that in both specimens the prefrontals are separated by the contact of the frontonasal and the frontal. This is noted as a variant in this species by Taylor (1935, Kansas Univ. Sci. Bull., 23: 375) but was not found to occur in any other UMMZ material (2 from Arkansas, 15 from Kansas, 4 from Missouri, 1 from North Carolina, 2 from Oklahoma). The newborn specimen is 50 mm. in total length; 23 mm. snout to vent. The typical adult pattern is present: a pair of narrow light (in life, very light yellow) lines laterally with a chestnut-brown band 3 scales wide between them; the 2 dorsolateral lines have 6 scales between them, the interspace being a lighter metallic brown with a faint middorsal light line; ventral surface gray, considerably darker than in the adult, with a conspicuous light chin; posterior two-thirds of tail bright metallic blue in life.

The distinct linear pattern of the young individual differs from a Missouri specimen (UMMZ 90465) of comparable size, which has no sign of body pattern. This difference between the eastern and western representatives of *E. anthracinus* has been pointed out by Smith (1946, Univ. Kansas Pub., Mus. Nat. Hist., 1: 87) but whether the Harris Lake population belongs to his "eastern" (*E. a. anthracinus*) population group, or to the nearby "southern" (*E. a. pluvialis*) population group, must be decided on the basis of a greater number of individuals from Alabama and a better diagnosis of the latter group.—HERNDON G. DOWLING, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan*.

REPLACEMENT FANGS IN NEWBORN TIMBER RATTLESNAKES.—A 41-inch timber rattlesnake, *Crotalus horridus horridus* Linnaeus, collected gravid on May 11, 1948, near President, Forest County, Pennsylvania, produced a stillborn snakeling at the Highland Park Zoological Gardens on August 18. The mother died the following day and a post mortem disclosed a second baby snake in the birth canal. Both young were dissected. On the left side of the mouth of the first specimen, a replacement fang had already assumed a position in the membranous sheath median to the functional fang and could be erected with it. Two additional reserve fangs lay well formed in the gum median and posterior to the left functional fang. On the right side 3 reserve fangs were found embedded in a similar position. In the second specimen there were 2 replacement fangs

formed in the gum on the left, and 3 on the right side of the mouth. The following table summarizes pertinent measurements:

Specimen number	Total length	Sex	Functional fang		First reserve		Second reserve		Third reserve	
			left	right	left	right	left	right	left	right
1	289	♂	3.2	3.3	3.0	3.1	2.4	2.9	2.0	2.1
2	268	♂	3.3	3.2	3.1	3.0	3.0	2.9	—	2.1

Measurements are in millimeters. Fang dimensions are straight line measurements.

The fact that a fang in the first specimen was already assuming the functional position suggests that the first shedding of maxillary fangs takes place at a very early age.—A. J. BARTON, *Highland Park Zoological Gardens, Pittsburgh 6, Pennsylvania.*

**EGGS OF THE SALAMANDER *ENSATINA ESCHSCHOLTZII PLATENSIS*.**—For 20 or more years during the summers I have searched with others for *E. e. platensis* (formerly *E. sierrae*, see Stebbins, 1949, Univ. Calif. Publ. Zool., 48: 447) and other plethodontids at 4500 feet in the Sierra Nevada along Park Creek, 4 miles above Sly Park, Eldorado County, California. Occasionally we found adult and young Sierra Nevada salamanders under logs or pieces of bark. They were usually near springs where the ground was wet. None has been found at the edge of Park Creek. Until August 8, 1949, the eggs of this plethodontid had not been found by any of us, even though we had turned over many thousands of logs, stones, and pieces of bark and torn apart many rotten stumps and logs. On that date, an adult male, an adult female, and 11 gelatinous eggs containing partly-developed embryos were found under the bark on a fallen log of Douglas fir (*Pseudotsuga taxifolia*). They were together, near the top of the log, about 2 feet above the ground. The tree had been down for about 15 years but was still firm. A small section of the log had been sawed and removed a few feet from where the animals were found. As a result of the cut the bark was cracked, thus enabling the salamanders to get beneath it. The small amount of shavings and rotted material present about the eggs was probably dry enough to burn. The nearest free water or wet soil was at a spring about 100 feet distant.

The eggs were almost spherical. After being preserved in alcohol, all of the outer diameters, each egg being measured from several positions, ranged from 10 to 11.5 mm. A membranous sheath covered all the eggs, holding them loosely together, appearing as though they were glued to each other. Each of the embryos was in about the same degree of development; 2 were removed, and both measured 13 mm. from snout to anus and 21 mm. in total length. The embryos had leaf-like gills and well developed digits. Each was curled around a large yolk mass.

Since the above was sent to the editor, an adult female curled about 12 eggs was uncovered on May 21, 1950. She was on the same log and only about 10 feet away from those collected on August 8, 1949. The eggs were from 6 to 7 mm. in outer diameter and were composed almost entirely of yolk with no visible embryos. When pieces of the rotted log about the eggs were squeezed between the fingers, drops of water were produced.

The only other records of *platensis* eggs known to the author are those provided by Robert C. Stebbins (MS on western North American amphibians). Two adult female *platensis*, each curled around an egg cluster, were found together under a rotten log at Park Creek, about 14 miles east of Placerville, Eldorado County, on September 9, 1948, by M. Wixman. The clutches were of 9 and 8 eggs, respectively, and all eggs appeared almost ready to hatch. A representative egg measured 10.5 mm. in outside diameter and one embryo was 25.1 mm. in total length. Robert C. Stebbins collected an adult female *platensis* at Jawbone Ridge, 3500 feet, Tuolumne County, California, on April 30, 1948. By implanting two pituitary glands of the newt *Triturus torosus* he induced her to lay 10 eggs between June 15 and 16. Four eggs were retained.—WALTER E. HOWARD, *Division of Zoology, University of California, Davis, California.*

THE DISTRIBUTION OF *CARPHOPHIS AMOENA* IN KENTUCKY.—Until recent years very little was known concerning the worm snake (*Carphophis amoena*) in Kentucky. According to Schmidt and Davis (1941, Field Book of Snakes: 102), the central worm snake, *Carphophis amoena helenae* Kennicott, ranges eastward ". . . to eastern Tennessee, West Virginia, and eastern Ohio," while the eastern worm snake, *Carphophis amoena amoena* Kennicott, ranges ". . . west into the Appalachian Mountains." Eastern Kentucky, according to this information, lies in the range of *C. a. helenae*.

Dury and Williams (1933, Bull. Baker Hunt Mus., 1: 14-15) reported 3 specimens of *Carphophis a. amoena* from Breathitt County, 2 specimens of *Carphophis a. helenae* from Carter County, and one specimen, with "the internasals and prefrontals fused on the left and separate on the right" from Knox County.

Welter and Carr (COPEIA, 1939: 129) reported *Carphophis a. helenae* from northeastern Kentucky, and stated it was "very abundant. Along the North Fork of Triplett large numbers were obtained beneath rocks. Among all typical *Carphophis* examined in eastern Kentucky, no typical *amoena* were found."

During the last ten years I have collected 58 worm snakes from five counties in the eastern mountainous section of Kentucky, and have examined a single specimen from an additional county in the collection of the University of Louisville, Louisville, Kentucky.

Three of the counties, Bell, Harlan, and Letcher, lie in the most mountainous section of the state. All are located along the Kentucky-Virginia border in southeastern Kentucky. The 33 specimens from these counties may be classified on the basis of the union or separation of the internasals and prefrontals as follows: separated, Bell County, one specimen in the collection of the University of Louisville; Harlan County, 16 united, 2 united on one side only, 5 separated; Letcher County, 6 united, 2 intermediate, 1 separated. Including the records of Dury and Williams (*loc. cit.*), 3 specimens, with the shields united, from Breathitt County (another typical mountain county), we find that of a total of 36 specimens, 26 have the shields united, 4 are intermediate, and 6 have the shields separated.

The other three counties in which collections were made lie along the western edge of the mountainous section of eastern Kentucky. Specimens from these counties may be classified, using the characters above, as follows: Fleming County, 13 with shields separated, 1 intermediate, 3 united; Pulaski County, 1 separated; Rowan County, 4 separated, 4 intermediate. Dury and Williams (*loc. cit.*) report specimens from Carter and Knox counties, also from the western edge of the mountainous section of the state. Summarizing these specimens, we find that of a total of 29, 20 have the shields separated, 6 are intermediate, and 3 have the shields united.

I have examined only 7 specimens from central and western Kentucky, from the counties of Green, Larue, and Warren. With the exception of a specimen from Warren County that has the shields united, all have them separated. Bailey (1933, Amer. Mid. Nat., 14: 210) reported only *helenae* from the Mammoth Cave region in Edmonson County, and Hibbard, (1936, Trans. Kansas Acad. Sci., 39: 280) states that many specimens (presumably the majority) have the shields separated.

In summary, it appears from these data that the worm snake of the mountainous region of eastern Kentucky is the eastern form, *Carphophis amoena amoena* Kennicott. Along the western edge of the mountains, a tendency toward intergradation appears, but the population is essentially *Carphophis amoena helenae* Kennicott, and this form is the worm snake of central and western Kentucky.—ROGER W. BARBOUR, *Oglebay Institute, Wheeling, West Virginia*.

SKITTERING LOCOMOTION IN *ACRIS CREPITANS*.—The recent note of Chabanaud (COPEIA, 1949(4): 288) on skittering locomotion of the African frog, *Rana occipitalis*, prompts me to record a similar observation on the North American hylid, *Acris crepitans*. In August, 1948, it was noted that juvenile *Acris crepitans* around a slough near Wewoka, Oklahoma, used this method of locomotion when disturbed. The slough was some 6 to 8 feet wide and about 100 feet long. The frogs, which were sitting along the bank, when disturbed almost invariably "bounced" two or three times on the water and landed on the opposite bank.—ALBERT P. BLAIR, *Dept. of Zoology, University of Tulsa, Tulsa, Oklahoma*.

LONGEVITY OF SNAKES IN CAPTIVITY IN THE UNITED STATES.—This list contains what records are available to us. We would like to hear from anyone having better records or ten-year records of other species. We intend to bring the list up to date each year as of the first of January. Only the oldest snake of each species, or subspecies, is listed. An asterisk indicates that the specimen was alive on January 1, 1950.

SPECIES	LOCATION	YEARS	MONTHS
* <i>Agkistrodon contortrix mokeson</i>	San Diego Zoo	13	6
* <i>Agkistrodon piscivorus</i>	R. M. Stabler	14	8
<i>Boa annulata</i>	Phila. Zoo	12	4
* <i>Boa enydris cookii</i>	San Diego Zoo	10	8
<i>Boiga dendrophila</i>	St. Louis Zoo	11	9
<i>Constrictor constrictor constrictor</i>	Phila. Zoo	12	3
* <i>Constrictor constrictor imperator</i>	San Diego Zoo	12	3
<i>Crotalus adamanteus</i>	No. Carolina St. Mus.	14	9
* <i>Crotalus atrox</i>	San Diego Zoo	13	7
<i>Crotalus basiliscus basiliscus</i>	San Diego Zoo	10	1
<i>Crotalus horridus horridus</i>	Syracuse Univ.	13	0
* <i>Crotalus mitchellii pyrrhus</i>	San Diego Zoo	10	1
<i>Crotalus ruber ruber</i>	San Diego Zoo	12	3
* <i>Crotalus tortugensis</i>	San Diego Zoo	12	9
* <i>Crotalus viridis helleri</i>	San Diego Zoo	12	10
* <i>Crotalus viridis viridis</i>	San Diego Zoo	11	1
<i>Drymarchon corais couperi</i>	Robert Riggs	12	11
<i>Dendroaspis viridis</i>	St. Louis Zoo	11	3
* <i>Elaphe guttata guttata</i>	Phila. Zoo	20	4
* <i>Elaphe obsoleta obsoleta</i>	Amer. Mus. Nat. Hist.	12	6
* <i>Elaphe obsoleta quadrivittata</i>	San Diego Zoo	12	7
<i>Epicrates angulifer</i>	Washington Zoo	11	9
* <i>Epicrates cenchria crassus</i>	Staten Island Zoo	12	2
<i>Epicrates cenchria maurus</i>	Bronx Zoo	27	4
<i>Epicrates striatus</i>	Phila. Zoo	16	0
<i>Eunectes barbouri</i>	Phila. Zoo	13	11
<i>Eunectes deschauenseei</i>	Phila. Zoo	13	10
<i>Eunectes murina</i>	Washington Zoo	28	0
<i>Helicops schistosus</i>	Phila. Zoo	12	3
* <i>Lampropeltis doliata amaura</i>	Geo. P. Meade	13	7
<i>Lampropeltis getulus brooksi</i>	San Diego Zoo	10	0
* <i>Lampropeltis getulus californiae</i>	San Diego Zoo	13	1
* <i>Lampropeltis zonata multicincta</i>	San Diego Zoo	10	4
<i>Lichanura roseofusca roseofusca</i>	San Diego Zoo	12	0
* <i>Masticophis flagellum piceus</i>	San Diego Zoo	11	8
* <i>Masticophis flagellum testaceus</i>	San Diego Zoo	13	2
* <i>Naja melanoleuca</i>	San Diego Zoo	21	3
<i>Naja naja</i>	Phila. Zoo	12	4
<i>Naja naja atra</i>	Brookfield Zoo	10	3
* <i>Naja nigricollis</i>	Brookfield Zoo	15	2
* <i>Naja nivea</i>	San Diego Zoo	12	11
<i>Ophiophagus hannah</i>	Grace O. Wiley	11	10
* <i>Pituophis catenifer annectens</i>	San Diego Zoo	13	4
* <i>Pituophis catenifer catenifer</i>	San Diego Zoo	10	7
* <i>Python curtus curtus</i>	St. Louis Zoo	16	7
* <i>Python molurus bivittatus</i>	Phila. Zoo	14	6
<i>Python molurus molurus</i>	Phila. Zoo	13	0
<i>Python reticulatus</i>	St. Louis Zoo	20	0
* <i>Python sebae</i>	Phila. Zoo	13	1
<i>Sistrurus catenatus</i>	Tabor College	14	0
<i>Ungaliophis guatemalensis</i>	Grace O. Wiley	17	8

C. B. PERKINS, Zoological Society of San Diego, San Diego, California.

## Ichthyological Notes

NOTES ON THE CENTRARCHID FISH *MESOGONISTIUS CHAETODON ELIZABETHAE* IN PENINSULAR FLORIDA.—In the course of sampling fish populations in various lakes and streams in central Florida during the past few years, I have been strongly impressed by the curiously restricted habitat distribution of the small black-banded centrarchid *Mesogonistius chaetodon elizabethae*.

This subspecies was described by Bailey (1941, Occ. Papers Mus. Zool., Univ. Mich., 454: 1-7) from specimens collected in Mill Dam Lake, Marion County, Florida, and Billy's Lake, Okefenokee Swamp, Georgia. Until 1946 Mill Dam Lake remained the only known Florida locality for the form. In that year A. C. Chable found *M. c. elizabethae* in North Lake, approximately 2 miles east of the type locality. Both bodies of water are in the Ocala National Forest, in the scrub and dune region of eastern Marion County.

In January, 1947, I collected a single specimen of this sunfish in Orange Lake, near McIntosh, Marion County, Florida, and the following month, took another specimen in the same locality.

Since Orange Lake offers a somewhat different series of habitats from those of the scrub lakes and lies approximately 30 miles northeast of the localities in the Ocala National Forest, my interest in the ecology and distribution of *M. c. elizabethae*, one of the rarest of Florida sunfishes, was aroused.

Bailey and Hubbs (1949, Occ. Papers Mus. Zool., Univ. Mich., 516: 34) have listed *Mesogonistius chaetodon elizabethae* among the forms which are typically Floridian, but which also occur in the Okefenokee Swamp of southern Georgia. In peninsular Florida this form has been taken only in the north central portion in lakes which at present, or in the past, represent a part of the St. Johns River drainage.

In addition to Mill Dam Lake, North Lake, and Orange Lake, previously mentioned, I have taken *M. c. elizabethae* in Hawthorne Prairie, and in Bower's Lake, and have records of it from a small, unnamed lake near Linadale. All of the localities are in Marion County in the higher well-drained regions of sandy soil underlain by Eocene limestone.

With the possible exception of Orange Lake, all of the lakes belong in the category of "sandhill lakes" as defined by Rogers (1933, Ecol. Monog., 3 (1): 16-17). These lakes are characteristic of the upland karst topography of north-central Florida. The shores are stable and sandy in nature, the *Pinus australis*-*Quercus laevis* plant association extending usually to within a few feet of the water's edge.

The main body of each of the larger sandhill lakes is subject to considerable wave action, which seems to inhibit abundant growth of submerged vegetation. *Sagittaria graminea* and *Panicum hemitomon* are the dominant plants in the shallow margins of these lakes, *P. hemitomon* extending from the shore outward to depths of 4 or 5 feet and forming the boundaries of the open water zone. The bottom in the open water zone is mostly sandy, overlain by a thin layer of silt and organic detritus. The water is usually clear.

Shallow embayments are characteristic of most of the sandhill lakes, and it is in these that plants and fishes occur most abundantly. *M. c. elizabethae* apparently finds optimum habitat conditions in these embayments.

The water of some of these coves is so shallow that vegetation fills them completely; in others it may form only a marginal zone of varying width.

Vegetation in the shallow water, out to depths of 2 or 3 feet, consists predominantly of *Sagittaria graminea*, *Panicum hemitomon*, *Nymphaeoides aquaticum*, *Castalia* sp., *Cabomba caroliniana*, *Eleocharis* sp., *Hypericum fasciculatum*, *Brasenia schreberi*, *Hydrocotyle umbellata*, *Utricularia foliosa*, and *Mayaca fluviatilis*.

Between the shallow margins described above and the deeper, more open regions of the cove, are found thick growths of *Myriophyllum* sp., beds of *Hydrotrida caroliniana*

and *Mayaca fluviatilis*, and scattered clumps of *Pontederia lanceolata*, *Bidens* sp., *Marciscus jamaicensis*, and *Nymphaea macrophylla*. Heavy mats of filamentous algae occur seasonally near the shore of some of the lakes.

Chable (1947, Unpubl. Master's Thesis, Univ. Florida: 58) gives data on the frequency of capture of *M. c. elizabethae* from Mill Dam Lake by small seine. On September 13, 1946, in a zone of emergent vegetation (*Brasenia-Utricularia*) in 0 to 2 feet of depth, 11 seine hauls yielded 8 specimens; while from a habitat of submergent vegetation (*Mayaca-Hydrotrida*) in 2 to 5 feet of water, 14 hauls yielded 26 fish.

In Mill Dam Lake it appears that collecting was most productive in deeper, open zones of submergent vegetation. Although I did not take precise data for other types of habitats, my experience in collecting this fish tends to confirm Chable's results.

Fish associations in the vegetated embayments of sandhill lakes are quite characteristic. Such littoral forms as *Leptolucania ommata*, *Fundulus chrysotus*, *Fundulus dispar lineolatus*, *Heterandria formosa* and *Gambusia affinis holbrookii* were taken always with *M. c. elizabethae*. Other fishes that normally inhabit the shallow protected shore zone of sandhill lakes, although not always recorded with *M. c. elizabethae*, include *Esox niger*, *Erimyzon suetta suetta*, *Chiroiceps goodei*, *Jordanella floridae*, *Lepomis marginatus*, *Chenobrytus coronarius* and *Micropterus salmoides floridanus*. *Esox americanus* and *Labidesthes sicculus vanhyningi* occur frequently in the shallow weedy margins of the lakes.

Hawthorne Prairie, although more typically a sandhill lake, represents a portion of Orange Lake that was connected with it in times past only during flood stage. Today the two are separated by a railroad and highway fill, with only one culvert to allow water flow.

Orange Lake, as mentioned above, offers the only known exception to the statement that all of the lakes in which *M. c. elizabethae* is known to occur are sandhill lakes. The bottom in the shore zone of Orange Lake is very unstable, being composed of flocculent decaying plant matter sometimes several feet deep. The border of the lake is in the process of succession to the typical marsh stage, which in places may be as much as a mile wide. Behind these there is an ill-defined swampy shoreline. Although the marshy portions are rich in vegetation, the bottom in the open water is mostly devoid of submergent plants. Beds of *Nymphaea macrophylla* and *Panicum* sp. are scattered through the open area. The water is tinted from large amounts of suspended plant detritus and plankton, in contrast to the clear water of the sandhill lakes.

The food of 5 specimens of *M. c. elizabethae* (32.8-36.3 mm. S.L.) from Bower's Lake was found to consist mostly of dipterous larvae, copepods, and cladocerans, with a few odonata nymphs and diptera pupae, and one hydronid. Chable (*op. cit.*: 59) found the food of 11 specimens of *M. c. elizabethae*, from the two lakes in the Ocala National Forest, to be mostly cladocerans, copepods and chironomid larvae plus small numbers of ostracods, amphipods, *Caenis diminuta* nymphs, *Enallagma* sp., caddis larvae and coleopterans.—GEORGE K. REID, JR., Department of Biology, University of Florida, Gainesville, Florida.

**AN ESTIVATING BOWFIN.**—On one occasion I was hunting squirrels in the Savannah River swamp near McBean, Richmond County, Georgia. While sitting quietly on a log, I was suddenly surprised to hear a thumping noise apparently emanating from the ground almost at my feet. Locating the sound, I dug into the ground to disclose, at a depth of about 4 inches, a roughly spherical chamber approximately 8 inches in diameter. In this chamber was a living bowfin, *Amia calva*. The fish was writhing about the chamber; the striking of its head against the chamber walls produced the sounds that had first attracted my attention. The surface soil was a hard, dried mud, but the walls of the chamber were soft and moist; they had been almost polished by the writhing of the fish. The river was nearly a quarter-mile distant, but the presence of yellowish silt on the nearby tree boles attested to previous flooding.

The situation immediately calls to mind the estivation of certain tropical lung-fishes. I suspect that *A. calva*, a species remarkably tenacious of life, could survive in a moist mud-chamber for considerable periods of time.—WILFRED T. NEILL, Research Division, Ross Allen's Reptile Institute, Silver Springs, Florida.

AN INSHORE RECORD OF THE BATHYPELAGIC FISH, *CHAULIODUS MACOUNI* BEAN, FROM BRITISH COLUMBIA.<sup>1</sup>—A specimen of *Chauliodus macouni* was taken in a shrimp trawl off the mouth of the Fraser River in the Strait of Georgia during April, 1947, at a depth of 40 fathoms. This record is unique, since the viper-fish is recognized as a bathypelagic species. The specimen is deposited in the collections of the Pacific Biological Station of the Fisheries Research Board of Canada.

The first British Columbian specimen of this species, the basis of the original description, was taken on August 31, 1888, by the United States Fish Commission Steamer "Albatross," off Cape St. James, Queen Charlotte Islands, at Station 2860, 51° 23' N. Lat., 130° 34' W. Long., at a standard depth of 876 fathoms (Bean, 1890, Proc. U. S. Nat. Mus., 13: 44). Since then a total of 367 specimens have been recovered in tow-nets by the International Fisheries Commission off the west coast of Vancouver Island, off the Queen Charlotte Islands and in the Gulf of Alaska, northward and westward to the Sanak Islands (Chapman, 1940, Occ. Pap. B. C. Prov. Mus., 2: 5). This species was taken by the "Albatross" during the year 1890, at Station 3340, south of the Alaska Peninsula, at a depth of 695 fathoms, and at Station 3347, off the northern coast of Oregon, at a depth of 345 fathoms (Gilbert, 1896, Rept. U. S. Comm. Fish., 1893: 402). It was also taken off the coast of California in 1904 by the "Albatross" in Monterey Bay, and off Santa Catalina and San Clemente Islands (Gilbert, 1915, Proc. U. S. Nat. Mus., 48: 321).

As the name implies, the fanged viper-fish has very long teeth. There are 4 very long anterior teeth on the premaxillary and excessively long anterior teeth on the mandibles. None of these teeth are received within the mouth. In addition to the canines, small, fine, pointed teeth occur in one row on the maxillaries and mandibles and in two rows on the palatines. The cleft of the mouth reaches beyond the eye. The dorsal fin is situated well in front of the pelvics and the first dorsal ray is produced into a filament about one-fourth as long as the body. The narrow pelvics are much longer than the head.

The counts and measurements are within the limits recorded by Chapman (*op. cit.*) for 13 specimens selected at random from the collection of the International Fisheries Commission. Standard length 78 mm. Length to origin of anal fin about 64.5 mm. Distortion of the body prevents precise measurements of this and some other body proportions. Predorsal length, 19.5 mm. Head length, 12.8 mm. Length of snout, 3.0 mm. Diameter of eye, 2.9 mm. Proportions in standard length: snout to origin of dorsal, 4.0; length of head, 6.1; snout to origin of pelvics, 2.36; snout to anal, 1.2. Proportions in length of head: diameter of eye, 4.4; length of snout, 4.2. Fin rays: D, 6; A, 11; P, 12; V, 7. Number of photophores: O-V, 18; V-A, 25; total in lateral row, 43; I-P, 9; P-V, 19; V-A, 26; A-C, 11; total in ventral row, 65; branchiostegal series, 19.

No help in the identification of this specimen is provided by Ege's (1948, Dana Rept., 31: 1-148, figs. 1-9, pls. 1-3) revision of the genus, which was based largely on material collected by the "Dana" during its cruise around the world in 1928-30 and on previous "Dana" expeditions. From a single specimen taken off the Gulf of Panama in the open Pacific, Ege concluded that *Chauliodus macouni* should be reduced to subspecific rank under the name *Chauliodus sloanei macouni*. He presumed that the specimens described by Bean (*op. cit.*), Gilbert (*op. cit.*) and Chapman (*op. cit.*) represented the temperate form of this subspecies and that the single specimen taken by the "Dana" represents the tropical form of the subspecies. These forms, which parallel those of other subspecies, were distinguished by certain numerical values.

Although the specimen from the Strait of Georgia agrees with the 13 specimens described by Chapman as *Chauliodus macouni*, it does not agree with the synopsis and diagnosis given by Ege for "*Chauliodus sloanei macouni*": the length to the origin of the anal fin, without the head, is 66.3 rather than 67.3 to 72.8 per cent of the standard length; the length of the foremost premaxillary tooth is 78 rather than 51.5 per cent as long as the largest premaxillary tooth; the number of organs in each section of the main row of smaller photophores, in the area between the longitudinal rows of large photophores, is 2 to 3 rather than 5. Further study is needed to determine whether, in line

<sup>1</sup> Contributions from the Scripps Institution of Oceanography, New Series, No. 467.

with these observed differences, the single specimen from the Strait of Georgia is not referable to *C. macouni*, or whether the one specimen available to Ege does not represent this species. In particular, the specimens in the collection of the International Fisheries Commission should be re-examined to redefine the diagnostic characters of *C. macouni*, particularly in regard to the section of the main row of smaller photophores in the area between the longitudinal rows of larger photophores (the character most strongly emphasized by Ege). Until such studies have been made, it is recommended that *C. macouni* be retained as a full species.

Sincere thanks are due Dr. Carl L. Hubbs for advice in the study of the specimen and in the preparation of the manuscript. The author is a graduate student on educational leave from the Fisheries Research Board of Canada.—W. E. BARRACLOUGH, Scripps Institution of Oceanography, La Jolla, California.

**THE BLUEBACK TROUT, *SVELVINUS OQUASSA* (GIRARD), IN MAINE.**—A "strange appearing trout" was sent to the Maine Department of Inland Fisheries and Game during the summer of 1948. The fish, completely eviscerated and in poor condition, was tentatively identified as a blueback trout. During the summer of 1949, 6 more specimens from two different localities were obtained through the efforts of Mr. Harry Leonard, Mr. Milton Hall and Mr. Herschel Currie, of Portage, Maine, and Mr. F. F. Blaisdell and Mr. Harry E. Maule, of New Jersey and New York respectively. One of the specimens taken by me from Pushineer Pond, Aroostook County, Maine, has been photographed and a color plate prepared.

Cooper (1940, Maine Dept. Inland Fish. and Game, Fish Surv. Rept. 3: 1-182) did not encounter any blueback trout in his survey of the Rangeley Lakes district of Maine in 1939, but had this to say about their occurrence and distribution: "Although this species has apparently become extinct in the Rangeley region, it is still known to occur in Rainbow Lake on the headwaters of the west branch of the Penobscot River in Piscataquis County, Maine. There is also the possibility that some undiscovered populations of the Blueback Trout may occur in some waters in the more northern parts of the state." As predicted, there are now specimens obtained from populations in Reed Pond in the Munsungan Lake region, and from Pushineer Pond in the Red River district of Aroostook County in northern Maine.

Although earlier accounts report the blueback as small, mature fish being 6-9 inches, the 7 specimens now in the University collection average much longer. The following lengths and weights have been recorded:

Specimen	1	2	3	4	5	6	7
Standard length (inches)	10.4	10.9	8.9	12.0	11.5	10.6	10.8
Fork length	11.5	11.9	9.6	13.1	12.5	11.6	11.9
Total length	12.3	12.4	10.3	14.0	13.4	12.5	12.8
Weight (ounces)	—*	—*	6	12	10	9	—*

\* Specimen eviscerated when obtained.

The bluebacks collected early in July were a dark blue on the back, fading out below the lateral line into a salmon color on the sides, belly and fins. Specimens examined the first part of September, as they neared the breeding season, were a deep red on the belly and fins. The teeth are well developed. The lateral line is very evident and the adipose fin is long and slender. It was noted that the gill rakers on 3 of the specimens were curled on the ends, a character which has been used to identify the Sunapee trout, *Salvelinus aureolus* Bean.

Further study will be necessary to determine fully the extent of the range, and to define the habitat requirements of the blueback trout in Maine.—W. HARRY EVERHART, Department of Zoology, University of Maine, Orono, Maine.

## REVIEWS AND COMMENTS

SEA TURTLES AND THE SEA TURTLE INDUSTRY OF THE WEST INDIES, FLORIDA AND THE GULF OF MEXICO, WITH ANNOTATED BIBLIOGRAPHY. By Robert M. Ingle and F. G. Walton Smith. University of Miami Press, Miami, 1949: 107 pp., 2 figs. \$1.00.—A summary of the status of the sea-turtle fishery in American Atlantic waters is a most welcome addition to herpetological literature. In addition to a digest of the statistics for American waters, other reports on the sea turtles are summarized, with suggestions for more thoughtful conservation legislation, and especially for further studies of important segments of the life-history that are too little known. The conclusions and recommendations are the following:

While some areas are overfished for turtles, others suffer only from reduced breeding activity. The principal danger to the turtle industry as a whole is interference with the nesting (i.e., egg-laying) turtle.

Growth rate and length of breeding season have been insufficiently studied.

Statistical information is inadequate for many centers of turtle fishing.

Experimentation with turtle farming should be initiated in favorable areas.

Egg taking and capture of turtles on beaches should everywhere be rigidly prohibited; size limits should be set, and closed seasons or maximum catch limits should be set by law wherever the average size of the turtles taken has dropped to a "dangerous extent."

An educational program is required to enlist the aid of fishermen and others in the collection of information and in law-enforcement.

The editing of this brochure and the plan of the bibliography leave much to be desired. On page 7, Kemp's turtle and the hawksbill are listed under "*Thallasochelys*" (= *Thalassochelys*). In the formal taxonomic list following, the hawksbill is *Eretmochelys* and Kemp's turtle is correctly referred to *Lepidochelys*; but on page 10, Kemp's turtle is placed in *Caretta*. My own analysis of the taxonomy of the sea turtles "Problems in the distribution of the marine turtles," (1905, *Marine Life Occ. Pap.*, 1: 7-10), was entirely missed, though it is properly listed in the *Zoological Record* for 1945. My paper on the amphibians and reptiles of Lower California is listed in the bibliography with the note "No sea turtles mentioned," and Stejneger's *Herpetology of Porto Rico* has the note "Of no value in the present connection." On such a plan, a bibliography of any subject could be vastly enlarged. Proof reading was not careful, for Hildebrand is misspelled directly above the correct spelling, Evermann is spelled with only one *n* throughout, and words from foreign languages and scientific names fare no better.—KARL P. SCHMIDT, *Chicago Natural History Museum, Chicago 5, Illinois*.

LES BATRACIENS DE L'INDOCHINE. By René Bourret, Institut Oceanographique de l'Indochine, Cau-dâ, Annam, 1942: Quarto, x + 547 pp., 196 text figs., 4 colored plates.—Apparently published during the Japanese occupation eight years ago, this monograph of one of the richest of amphibian faunas appears to have been overlooked by most herpetologists. It follows and, incidentally, quite overshadows the author's previous monographs of Indochinese snakes and turtles. Moreover, it is not confined to French territory, but covers all of Burma, Siam, French Indo-China, and the Malay Peninsula. Thus, in the continued absence of the amphibian volume of Malcolm Smith's *Fauna of British India* series, it forms the principal modern treatise on the amphibians of the tropical Oriental Region.

The volume includes: (1) a table of localities cited, with map reference; (2) an historical introduction; (3) an extremely useful bibliography; (4) general notes on morphology, tadpoles, natural history, and geographical distribution; (5) keys to all genera and species, including known tadpoles; (6) a complete, illustrated, systematic account of the caecilians, salamanders, and frogs of the region; (7) an alphabetical index; and (8) a table of contents. No date appears anywhere on the volume save at the bottom of the paper back (1942). The number of recognized forms is 171.

The collections upon which the book is based seem to have been those gathered by the author from French Indo-China, and the descriptions of species not found there are compiled from the literature. In some ways this sort of treatment adds rather than detracts from the value of the work, especially the reproduction of a large number of figures of type specimens from the scattered basic literature. The classification is modern, but some work has been overlooked. The author is unaware that the presumed Siamese ambystomid salamander (*Ambystoma persimile*) was shown years ago to be a myth, he did not see Davis's proof that "*Bufo*" *borbonica* is a firmisternal frog (*Cacophryne*), and he did not (for obvious reasons) see Deckert's revisional work on the ranids. These defects are perhaps ascribable to the author's isolation in Indo-China. However, comparatively little is overlooked, and because of its size, completeness, and fullness of illustration, this work is the most important single systematic treatise on amphibians published in many years.

—GEORGE S. MYERS, *Natural History Museum, Stanford, California.*

**PROPOSED REPRINTING OF BOULENGER'S HERPETOLOGICAL CATALOGUES.**—The notice published two years ago under the above heading, by the undersigned, (1948, COPEIA: 229), asked for post-card replies from persons and institutions interested in purchasing one or more of the nine volumes of Boulenger's monographs of living reptiles and amphibians, if the British Museum could be induced to reprint them. The replies were disappointing, although not overly so to anyone who has had experience with the lethargy of the public (scientific or not) in replying by mail to any sort of notice. Summation of the replies indicated approximately 65 purchasers for each of the nine volumes. All replies were forwarded to Mr. H. W. Parker, of the British Museum, in May, 1949.

Reply has just been received from Mr. Parker. He has gotten estimates of reproduction of the volumes, which he says would now have to be sold at close to £ 2/ 10 s. (\$7.00 at current exchange) per volume. This is a considerable advance over the original price and Mr. Parker does not believe that over 150 copies of each volume could be sold. If so, the British Museum could not assume the financial risk of reprinting, especially because they operate on public funds. However, if the demand is insistent and a larger sale seems likely, it is still possible that the B.M. might be induced to reprint at least one of the catalogues. The writer's own belief is that the three-volume *Catalogue of Lizards* would be most useful and sell best, as its classification has perhaps been less outmoded than that of the others and replies indicate a slight preference for it over the other titles.

It was surprising that not over a half-dozen institutional libraries inquired about the reprinting. Surely far more would be interested. Moreover, certain institutions that specialize in herpetological instruction might estimate a small but continuing demand on the part of graduate students. In any event, those who are interested (including those who wrote before) may wish to urge that the project not be dropped. Communications should be addressed to MR. H. W. PARKER, Keeper of Zoology, British Museum (Natural History), Cromwell Road, London, S. W. 7, England.—GEORGE S. MYERS, *Natural History Museum, Stanford University, California.*

## EDITORIAL NOTES AND NEWS

Edward Avery  
McIlhenny

EDWARD AVERY McILHENNY died August 8, 1949. He will be remembered by his immediate associates for his charity, his generosity, and his multiple benefactions. His success in winning the passing of legislation favorable to wildlife and his work in establishing the first wildlife refuges on the Gulf Coast have established his name in the history of the conservation movement. His researches on the natural history of fish, reptiles, birds, and mammals have made him known to all vertebrate zoologists. The warmth of his hospitality to scientists has left many with a close personal memory of Mr. McIlhenny and Avery Island.

He was born at Avery Island, Louisiana, March 29, 1872, and was educated at home until 1886. During the next two years he attended Wyman's Military Academy, Upper Alton, Illinois, and then went to Holbrook's Military Academy, Ossining, New York. He entered Lehigh University in 1892 but left Lehigh in 1894 to join Dr. Frederick A. Cook's expedition to the Arctic. On his return to Avery Island in 1895 he was struck by the severe reduction in the number of egrets and established a local colony by holding birds captive until they desired to remain in the vicinity. This was the first attempt to preserve a vanishing species of North American birds.

His brief taste of the Arctic tempted McIlhenny to return to that area in order to collect bird specimens and he organized his own expedition and left San Francisco for northern Alaska, June 19, 1897. He wintered at Point Barrow, the most northern point on the North American continent and then hunted and explored the Siberian Coast.

On his return to Avery Island he married Miss Mary Matthews, and took up residence on the family estate of Avery Island. His trip to the Arctic had merely whetted his interest in the field of conservation and stimulated him to do additional work in natural history. His egret colony was expanding rapidly, and his interest in plant life caused him to introduce varieties of plants from many parts of the world to establish an arboretum since called Jungle Gardens.

The intensity of the continued reduction of water fowl along the Gulf Coast clearly indicated the need for the establishment of wildlife preserves. On November 4, 1911, Charles W. Ward joined with Mr. McIlhenny and donated to the state of Louisiana 13,000 acres of wildlife refuge, the first wildlife refuge in the United States privately donated for the public good. In 1912 Mr. McIlhenny presented to Mrs. Russell Sage through the assistance of Mrs. Robert W. DeForest a proposition for the establishment of a wildlife refuge on Marsh Island for the purpose of preserving migratory water fowl. George Bird Grinnell was sent to inspect this property, and his report being favorable, Mrs. Sage purchased Marsh Island, an area of 75,663 acres, on July 22, 1912, and created on it a refuge for migratory wildlife.

Still dissatisfied with the refuge areas available McIlhenny, through the assistance of Mrs. Robert W. and Henry W. DeForest, was put in touch with the Rockefeller interests and presented to John D. Rockefeller a plan to purchase a large area of land along the Gulf Coast in Vermilion and Cameron parishes for the purpose of creating an additional migratory wild fowl refuge. The Rockefeller Foundation purchased and turned into a wildlife refuge 86,000 acres of land on the 20th of May, 1914.

On December 15, 1919, all three of the properties described were deeded to the state of Louisiana to be held in perpetuity as wildlife refuges. The three refuges together included more than 174,663 acres.

E. A. McIlhenny's early interest in birds was rapidly expanded to other forms of wildlife. After his work in establishing refuges and the passing of conservation laws in the southern states he turned his attention to the study of the local fauna. His publications include more than 48 books and articles relating to natural history. Most of these concern ornithology, but the variety is indicated by some of the titles. In 1933, he published a volume entitled "Befo de War Spirituals." In the next year, 1934, he published an article entitled "A Brief for the Y Chromosome" in the *Journal of Heredity*. Possibly his most outstanding biological publication of concern to the herpetologist is his book on the life his-

tory of the alligator. This volume summarized for the first time the life history of the alligator and described many phases in detail. Too, it presented many problems for future students to explore and suggested a management plan and conservation laws for the protection of the alligators.

His writings show the enthusiasm of the naturalist, the appreciation of beauty of a lover of nature and the attention to detail of a scientist, but a formal listing of McIlhenny's titles would give but a scant indication of the scope of his knowledge of natural history. Every biologist who was fortunate enough to chat with him about the local animal and plant life was impressed by the breadth of his knowledge and was stimulated by the intensity of his personality.—FRED R. CAGLE, *Tulane University, New Orleans 18, Louisiana*.

**Summary  
of the 1950  
Meeting**

**T**HE thirtieth annual meeting of the AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS was held in Salt Lake City, Utah, June 19 to 23, 1950, in conjunction with the WESTERN DIVISION OF THE SOCIETY and with the PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

**Activities  
of June 19**

**R**EGISTRATION was held in the Union Building, University of Utah. At 2 P.M. an excursion by bus toured the famous opencut copper mine in Bingham Canyon and also visited Great Salt Lake.

**Governors'  
Meeting**

**T**HE Board of Governors' meeting held in the Union Building was called to order by PRESIDENT M. GRAHAM NETTING at 8:30 P.M. with 22 Governors present. The reading of the minutes of the last meeting was dispensed with inasmuch as they were published in COPEIA, 1949 (4). The 120 new members obtained since the 1949 meeting were formally elected to membership.

A resolution was passed amending the by-laws to the effect "that elective members of the Board of Governors whose terms have expired at the time of the annual meeting shall not be eligible for reelection to the Board until the time of the next annual meeting." The following were elected to serve on the Board until 1955: J. L. BAUGHMAN, A. F. CARR, JR., HENRY S. FITCH, EARL S. HERALD, JOHN C. MARR, GEORGE A. MOORE, PAUL F. NEEDHAM, M. GRAHAM NETTING, ROBERT C. STEBBINS, BOYD W. WALKER. Also T. PAUL MASLIN was elected to fill a vacancy in the 1951 group and ROSS HARDY a vacancy in the 1954 group. No vacancies were reported in the Honorary Foreign Membership.

The Secretary reported on the status of the Endowment Fund that totals \$4697.05, \$4000 of which is invested in Series E U. S. Savings Bonds. The Board voted to continue to add the interest to the principal until it is necessary to use it, at the option of the Board.

The Secretary reported on the status of the Special Gift Fund henceforth to be known as the FREDERICK H. STOYE FUND. The fund consists of \$3000 invested in Series G U. S. Savings Bonds paying interest at the rate of 2½ % per annum. The Board passed a resolution amending the by-laws to the effect that "The Frederick H. Stoye Fund shall remain invested (in bonds) until maturity and then be reinvested with the principal left intact. The income is to be used to offer awards for meritorious papers presented by students without regard to membership in the Society, at the annual (National) meeting. After the demise of Mr. Stoye the principal of the fund is to remain invested as now, and the income used to provide student awards at all the meetings, or to be used in any manner that the officers of the Society may decide. The prizes awarded at the meetings are to be known as the Frederick H. Stoye Awards." The Board directed the Secretary to convey to Mr. Stoye the thanks of the Society for his generous gift.

The Secretary reported on the Revolving Research Fund in the absence of FREDERICK H. STOYE, the Chairman of the Committee. The fund now consists of \$1370.25. A grant of \$60 was made on Dec. 15, 1949, to ROYAL D. SUTTKUS, graduate student at Cornell University, to enable him to collect *Notropis* in Alabama, Georgia and Florida for taxonomic study in connection with his doctoral dissertation. On Jan. 14, 1950, JOHN E. WERLER, San Antonio Zoological Society, repaid \$150.00 borrowed from the Fund in 1948. Applications for small sums to support research projects are invited and should be sent directly to F. H. STOYE.

The Treasurer was empowered to send 50 pounds to the Zoological Society of London, as a gift from the Society toward the cost of the 1949 *Zoological Record*.

It was recommended by the Board in response to an invitation from the Chicago Natural History Museum that the 1951 meeting be held in Chicago. Overwhelming opinion favored a June meeting. It is also recommended that the 1952 meetings be held in Austin, Texas. The invitation was issued by members at the University of Texas who were joined in the invitation by the following groups: Texas Herpetological Society, Texas Game, Fish and Oyster Commission; Texas Academy of Science; Texas A and M College; Texas Christian University; State Marine Laboratory; and Institute of Marine Science. The time suggested is spring vacation period in late March or early April.

The Board elected EDWARD C. RANEY for a three-year term as the Society's representative on the Governing Board of the American Institute of Biological Sciences and as representative to the Division of Biology and Agriculture of the National Research Council.

The Secretary reported on the meeting of the Governing Board of the American Institute of Biological Sciences held on May 8, 1950, in Washington, D.C. The American Institute of Biological Sciences now has a full time Executive Secretary, Dr. CLARENCE J. HYLANDER, and three assistants. Recently all members received an A.I.B.S. Information Booklet and the April 1950 issue of the A.I.B.S. News Letter which outlines the main accomplishment of the Institute to date. Plans were discussed for setting up a job placement service for biologists and it was agreed that the implementation of such a placement service be left to the discretion of the Executive Committee and the Executive Secretary of the A.I.B.S. It was reported that *Biological Abstracts* is "in the black" financially but needed additional funds to publish the 1949 and 1950 indices on time. Two proposals were approved as follows: (1) that the American Institute of Biological Sciences assist in obtaining funds for the publication of the 1949 and 1950 indices of *Biological Abstracts*, through sponsoring a contract between the National Academy of Sciences and such government agencies as might desire to co-operate, (2) that American Institute of Biological Science endorse the value of *Biological Abstracts* as an agency for producing the 1949 and 1950 indices. It was left to the discretion of the Executive Committee to work out the details of the arrangement and approval of the contract. Under the A.I.B.S. guidance three Advisory Committees in Biology are now set up and operating to screen research projects submitted to the Office of Naval Research. The General Biology Committee is the one that would consider projects of interest to our Society and one of our members, DANIEL MERRIMAN, is on that Committee. The Handbook of Biological Data sponsored by the A.I.B.S. is nearing completion and will be published by Saunders at \$5.50. The deadline for manuscript is October, 1950. The Board of Governors approved continuation of our membership in the A.I.B.S. for another year. The Secretary welcomes suggestions concerning projects of interest to our members that the A.I.B.S. can implement.

The Board apportioned not more than \$5000 of the Society's funds for the publication of *COPEIA* during the year. This is an increase of \$500 over last year. The Treasurer of the Society was requested by the Board to present a provisional budget for the next calendar year. The Society has been incorporated in the District of Columbia and in this connection a constitution and by-laws need to be approved. The Secretary has prepared a preliminary draft which includes our present By-laws. This is to be sent to members of the Board of Governors for suggested changes before adoption by a mail ballot.

A resolution was approved directing the officers of this Society to ask the *Historian* for an accounting of his tenureship and a full statement of the Society's material now in his custody, this report to be given at the Chicago meeting. The Secretary was instructed to thank ARTHUR W. HENN, former Treasurer of the Society, for his suggestion regarding the establishment of Honorary Life Members and Emeritus Life Members. ROBERT R. MILLER gave a report of a study made regarding comparative costs of the publication of *COPEIA* and of reprint costs and the Board approved a motion thanking him for his efforts.

The President appointed the following committees:

*Resolutions:* JOHN C. MARR and ROBERT R. MILLER

*Auditing:* CARL L. HUBBS and TRACY I. STOREY

*Awards:* ROSS HARDY, ROBERT C. STEBBINS, FRANCES N. CLARK, MILTON B. TRAUTMAN

Sessions  
of June 20

THE morning session was a joint session with the WESTERN SOCIETY OF NATURALISTS and was convened at 9 A.M. in the Biology Building, University of Utah, with the President of the Western Division, JOHN L. HART, presiding. The program was opened by a short presidential address, by M. GRAEME NETTING, entitled "The role of amphibians and reptiles in soil and water conservation." There followed a symposium: "Survival of hatchery-reared trout" with PAUL R. NEEDHAM acting as chairman and discussion leader. The following papers were read:

*Return from hatchery trout in Michigan.*—Gerald P. Cooper.  
*Anticipated survival as one basis for establishing a fish stocking policy.*—A. F. C. Greene.  
*Survival of hatchery-reared trout in Utah.*—M. J. Madsen.  
*Factors influencing survival of trout.*—Paul R. Needham.

The group photograph was taken at noon at the entrance of the Biology Building. This excellent photograph may be obtained directly from the Photographic Bureau, University of Utah, Salt Lake City, for \$5.50 by specifying picture number 988.

Two sessions were held concurrently in the Biology Building in the afternoon beginning at 1:30 P.M. The ichthyological session was a joint session with the WESTERN DIVISION OF THE AMERICAN SOCIETY OF LIMNOLOGY AND OCEANOGRAPHY with EDWARD C. RANEY presiding. The following papers were read:

*Tempo and mode in fish evolution.*—George S. Myers.  
*Geographic distribution of fishes on the Pacific Coast of Central America.*—Clark Hubbs.  
*The use of self-contained diving gear for observing fish.*—Conrad Limbaugh.  
*Some results of phylogenetic studies on agonid fishes.*—Harry W. Freeman.  
*The hatching stimuli for the eggs of the grunion and the California flying fish.*—Boyd W. Walker.  
*Spawning of the grunion.*—Boyd W. Walker.  
*A proposed cross index of all fisheries and ichthyological literature.*—Rolf L. Bolin.

The herpetological session, a joint session with the HERPETOLOGISTS LEAGUE, began at 1:30 P.M. with EDWARD H. TAYLOR presiding. The following papers were read:

*Several years observation on two water moccasons.*—Robert M. Stabler.  
*Variation in scale and color patterns of the wandering garter snake in Utah and southern Idaho.*—Wilmer W. Tanner.  
*Costa Rican salamanders and their distribution.*—Edward H. Taylor.  
*A series of papers dealing with snake den studies in Tooele County, Utah:*  
 Introduction.—Angus M. Woodbury.  
*Temperature correlations with entrance and emergence.*—Basil Vetas.  
*Sex ratios of the den population.*—Cordon Julian.  
*Age and growth in the Great Basin rattlesnake and the western striped racer.*—F. LaMarr Heyrend and Anson Call.  
*Egg production in the Great Basin rattlesnake.*—Henry R. Glissmeyer.  
*Color pattern in the Great Basin rattlesnake.*—Earl W. Smart.  
*Effects of venom injections on rattlesnakes.*—Raymond Sanders.

At the end of this session a short discussion was held regarding the role of our Society and the Herpetologists League in the field of Herpetology.

Sessions  
of June 21

CONCURRENT sessions were again held in the Biology Building at 9 A.M. The ichthyologists joined the AMERICAN SOCIETY OF LIMNOLOGY AND OCEANOGRAPHY in a Symposium: "Relation of fisheries to their physical and chemical environment" with NORRIS W. RAKESTRAW presiding. The following papers were read:

*Relation of the sardine (pilchard) to environmental conditions.*—Elbert H. Ahlstrom.  
*Physical and biological factors affecting distribution of dissolved oxygen.*—Warren S. Wooster.  
*Effects of turbidity and siltation upon the fresh water faunas and fisheries of the eastern United States.*—Milton B. Trautman.

*The relation of Albacore catches to water temperatures.*—John L. Hurt.

The herpetological sessions held jointly with the HERPETOLOGISTS LEAGUE convened at 9 A.M. with ROSS HARDY presiding. The following papers were read:

*Lizards of the genus *Sceloporus* in Colorado.*—T. Paul Maslin.  
*Ecological life history of *Syrrophus marnockii* Cope.*—David L. Jameson.  
*Remarks on the systematics of the crested lizards of the genus *Dipsosaurus*.*—John Lamont and Jay M. Savage.  
*The nature and relationships of the amphibians of the Solomon Islands.*—Walter Brown.  
*Thermoregulation and eccrine body temperatures in the American toad, *Bufo terrestris americanus*.*—Charles M. Bogert.  
*The systematic status of the Baja California night lizards related to *Xantusia vigilis*.*—Jay M. Savage.  
*The evolution of the iguanid genus *Uma*.*—Kenneth S. Norris.

Following the reading of papers the business meeting of the Western Division was dispatched with brevity and the following officers were elected: ROSS HARDY, President; BOYD W. WALKER, Vice-President; ANITA E. DAUGHERTY, Secretary-Treasurer.

The afternoon session, also a joint session with the HERPETOLOGISTS LEAGUE, was convened at 1:30 P.M. by the presiding officer, M. GRAHAM NETTING, and the following papers were read:

Observations on the yellow-leg frogs (*Rana boylii*) of southern California.—Richard G. Zweifel.  
Some Mexican Kinosternidae.—Norman Hartweg.  
Fossil and living amphisbaenids of the United States and Mexico.—Edward H. Taylor.

Next came a Symposium entitled "Population analysis techniques" at which Ross HARDY acted as discussion leader. The following papers were given:

Methods of marking fish and analysis of recoveries.—Frances N. Clark.  
Trapping techniques for amphibian life histories.—William D. Stull.  
Analysis of a marked tortoise population.—Ross Hardy.  
Live trapping as a means of sampling reptile populations.—Henry S. Fitch.  
Methods of studying snake den populations.—A. M. Woodbury.

A meeting of the Committee on Fish Classification was also held at 1:30 P.M. with about 20 interested ichthyologists and the following committee members present: GEORGE S. MYERS, Chairman, ROLF L. BOLIN, REEVE M. BAILEY, EDWARD C. RANEY, and JOHN TEE-VAN.

**Business Meeting**

THE annual business meeting was called to order by PRESIDENT NETTING at 4 P.M. The minutes of the 1949 meeting, published in COPEIA 1949 (4), were not read. The Secretary reported that 120 new members were obtained since last meeting and one member was reinstated. During the same period 16 members resigned, 153 members were dropped for non-payment of dues, and 2 members died, making a total loss of 171 and a net loss of 50, leaving the total membership at 901. Of these, 39 are fully paid, and 11 are partly paid Life Members. The Society gained 20 new subscribers and reinstated one making a gain of 21 and a total subscription list of 272. Combined members and subscribers number 1175. Geographic tabulations indicate that 220 copies of COPEIA go to 41 foreign countries. Canada leads with 49, followed by U.S.S.R. with 32, and England with 19. Domestic copies total 955; California leads with 139, followed by New York with 117, Michigan with 65, Illinois with 51, Pennsylvania with 51 and Texas with 49. Delaware continues to be the only state without a member or subscriber. Beginning with COPEIA 1950 (1), 1500 copies were printed, an increase of 100 over last year.

The following financial report for the calendar year January 1 to December 31, 1949, submitted by the Treasurer, ARTHUR W. HENN, was read by the Secretary.

**RECEIPTS**

**Dues received**

Current dues for 1949, at \$5.00 (or \$4.50) per member .....	\$4,030.15
Back dues for 1948 and before, at \$4.00 per member .....	153.00
Advance dues for 1950 and beyond at \$5.00 (or \$4.50) per member .....	114.50

\$4,297.65

**Subscriptions received**

Current subscriptions for 1949, at \$5.00 each .....	577.70
Back subscriptions for 1948 at \$5.00 each .....	89.50
Advance subscriptions for 1950 and beyond at \$5.00 each .....	382.50

577.70

89.50

382.50

1,049.70

1,156.22

352.11

12.18

17.45

**Contributions**

From ROGER CONANT toward color plate in COPEIA 1949 (1) .....	100.00
From CARL L. HUBBS, for Western Division prizes .....	40.00
From F. H. STOYE, prizes for Washington meeting .....	25.00

100.00

40.00

25.00

50.00

165.00

Credit, check returned .....	25.00
Credit, interest for 6 months on Government Bonds held in the Endowment Fund .....	50.00

25.00

50.00

Total receipts during 1949 .....	7,325.31
Excess of expenditures over receipts .....	274.81

7,325.31

274.81

7,060.12

## EXPENDITURES

Costs of publication of COPEIA	
COPEIA, 1948, no. 4	\$1,328.74
Index for 1948 in this issue	140.00
COPEIA, 1949, no. 1	1,181.59
Color plate of snakes, which was published in this issue	513.62
COPEIA, 1949, no. 2	928.43
COPEIA, 1949, no. 3	988.61
 Total for four numbers paid during 1949	 \$5,080.99
Reprint costs of COPEIA (will be returned to the society)	
COPEIA, 1948, no. 3	\$ 250.62
COPEIA, 1948, no. 4	306.60
COPEIA, 1949, no. 1	270.84
COPEIA, 1949, no. 2	205.73
 Total paid out for four numbers	 1,033.79
Printing of stationery, due-bills, statements, nomination blanks, window envelopes, etc.	229.31
Services necessary to operate the Society, chiefly stenographic services to collect dues and subscriptions	281.70
Postage	
Western Division	\$ 20.00
Ichthyological Editor	20.00
Editor-in-chief (for several years)	100.00
Pittsburgh	10.00
Ithaca (chiefly for due bills)	176.95
 Annual Meeting in Washington, D.C.	 326.95
Total costs including announcement, programs, postage, travel, local entertainment, etc.	\$ 154.76
Prizes awarded at Annual Meetings (this money had been previously contributed)	
Washington meeting—HERNDON DOWLING	\$ 25.00
Western Division—FREDERICK H. C. TAYLOR	15.00
Western Division—ROLAND W. RADCLIFFE	15.00
 Corporation of the Society (fees, travel, subsistence)	 55.00
Refunds	85.13
 Contributions	 200.00
Remittance of 25 pounds to the Zoological Society of London to assist in publication of the 1947 "Zoological Record"	101.90
Transfer	
Of over-payment from Hubbs, for prizes at Western Division, to the Revolving Research Fund	10.00
Miscellaneous debits such as postage on back issues of COPEIA and sales tax on reprints from COPEIA	40.59
 Total expenditures or disbursements	 \$7,600.12

Bank balance in the checking account in the Mellon National Bank and Trust Co. of Pittsburgh, Pa. Credit balance, after payment of all of above items, and allowing for uncleared checks, as of December 31, 1949, was \$5,762.01.

The *Auditing Committee* of TRACY I. STORER and CARL L. HUBBS reported that as far as could be determined by the records at hand the report of the Treasurer was correct. On June 10, 1950, the incumbent Treasurer, DWIGHT A. WEBSTER, informed me that the Society had \$6060.61 in its checking account in the First National Bank, Ithaca, New York.

GERALD P. COOPER, Ichthyological Editor, gave an informal report on the activities of the editorial office and stated that there is on hand approximately enough fish manuscript for three issues of COPEIA. The Secretary gave a report of the Board of Governors meeting held on June 19, 1950. VICE-PRESIDENT FRED R. CAGLE reported via the Secretary regarding a moderate membership campaign initiated in September, 1949. He indicated disappointment with the results since only one new subscription and 11 new members were secured although 34 letters were written to institutions and 185 to prospective members. However, it would appear that others of the total of 120 new memberships added throughout the year joined because of Cagle's efforts. He suggests that established members constantly co-operate in recommending individuals who are potential permanent members.

The *Nominating Committee*, consisting of CHARLES M. BOGERT, *Chairman*, HENRY S. FITCH, W. I. FOLLET, NORMAN HARTWEG and LUIS R. RIVAS, reported and the following slate of officers was elected: JOHN TREADWELL NICHOLS and HELEN T. GAIGE, *Honorary*

*Presidents; GEORGE S. MYERS, President; ROBERT C. STEBBINS, FREDERICK H. STOYE, and FRED R. CAGLE, Vice-Presidents; EDWARD C. RANEY, Secretary; N. B. GREEN, Publications Secretary; DWIGHT A. WEBSTER, Treasurer; GERALD P. COOPER, Editor-in-Chief; ROBERT R. MILLER, Ichthyological Editor; NORMAN HARTWEG, Herpetological Editor; ROLF L. BOLIN, E. R. DUNN, WILLIAM A. GOSLINE, LUIS R. RIVAS, and A. M. WOODBURY, Editorial Board.*

PRESIDENT NEITTING transmitted a communication from DORIS COCHRAN concerning CARE packages sent to destitute European colleagues during the past year. Contributions for future parcels are solicited and should be sent to Dr. Cochran.

The following resolution was introduced by ROLF L. BOLIN and was unanimously carried, to the effect that "The Society approves of the proposed plan for a bibliographic cross index of all fishery and ichthyological literature on punch cards and recommends it to the National Research Council and other interested organizations for most careful consideration."

**Annual  
Dinner**

THE annual dinner of the Society was held in the Colonial Room of the Union Building, University of Utah at 6 P.M. The assemblage of 90 people was regaled by the toastmistress, MRS. A. M. WOODBURY, who entertained by appropriate stories as she introduced the new officers. The report of the *Resolutions Committee* was read by JOHN C. MARR. At 8:30 P.M. the dinner guests adjourned to Kingsbury Hall to hear the address of LAURENCE M. KLAUBER, President of the Pacific Division, American Association for the Advancement of Science, entitled "Rattlesnakes and Man."

**Activities  
of June 22**

AT 9 A.M. an open meeting of the standing *Committee on Fish Classification* was held with the Chairman, GEORGE S. MYERS, presiding, and with committee members ROLF L. BOLIN, CARL L. HUBRS, REEVE M. BAILEY, EDWARD C. RANEY, LEONARD P. SCHULTZ and JOHN TEE-VAN and about 25 other members present. The meeting opened with a paper by LEONARD P. SCHULTZ entitled "Results of a preliminary survey of zoological opinion on fixing the endings for various categories of classification." The work of the committee proceeded, aided by contributions from other members. The results will be published in COPEIA. The meeting adjourned at 11:45 A.M.

During the afternoon some members participated in a field trip through Provo Canyon arranged by M. J. MADSEN and led by A. I. JOHNSTON of the Utah Fish and Game Commission. Others traveled to Great Salt Lake for a swim in its fanned waters. Many members attended the Biologists' dinner held at 6 P.M. in the ballroom of the Union Building.

**Sessions  
on June 23**

THE session was held in the Biology Building and opened at 9 A.M. with GEORGE S. MYERS presiding. The following papers were read:

The origin and dispersal of the fishes of the family Poeciliidae.—Luis Rene Rivas.  
Attempts at improvement of museum technique.—W. I. Follett.  
Anatomy and evolution of the bathypelagic fishes of the family Paralepididae (Order Inomi).—  
Robert R. Harry.  
The status of the blennioid genera *Epigeneichthys* and *Xiphister*.—Norman J. Willmovsky.  
The changing fish fauna of the lower Colorado River system.—Robert R. Miller.

The prize award of \$25 for the best ichthyological paper presented by a student went to ROBERT R. HARRY and the second prize of \$15 to CONRAD LIMBAUGH. The basis for these awards was (1) value to science of the contribution, (2) organization and presentation, (3) correct use of English and delivery, and (4) keeping within the time limit. First prize of \$25 in herpetology went to RAYMOND SANDERS and in a tie for second place were RICHARD G. ZWEIFEL and JAY M. SAVAGE, both of whom were awarded \$15. These awards were made possible through donations made by ANITA E. DAUGHERTY, RAYMOND E. JOHN-  
SON, FREDERICK H. STOYE and WILLIAM D. STULL.

The report of the *Resolutions Committee* follows:

*Whereas*, the 30th Annual Meeting of the American Society of Ichthyologists and Herpetologists, held at the University of Utah in Salt Lake City from June 19 through June 23, 1950, has been successfully completed:

*Therefore, be it resolved*: (1) that the members of this Society express their deepest appreciation for the unlimited courtesy and hospitality extended to them by the *Local Committee*: A. M. WOODBURY (chairman), VASCO M. TANNER, STANLEY B. MULAIK, DOROTHEA D. MULAIK, and ROBERT C. PENDLETON, and the wives of some, as well as their other assistants. (2) That ROSS HARDY as *Chairman of the Program Committee* be thanked for his success in arranging a fine program of scientific papers. (3) That we owe special thanks to the officials of the University of Utah for hospitality and for the use of many of their facilities. (4) That we owe thanks to the Utah Fish and Game Commission for arranging a field trip. (5) That we are appreciative of the programs planned for the entertainment of wives and friends of members by the faculty members' wives and others.

*Whereas*, HELEN T. GAIGE has submitted her resignation as Editor-in-Chief of *COPEIA*, journal of the American Society of Ichthyologists and Herpetologists, and *Whereas*, KARL P. SCHMIDT has submitted his resignation as Herpetological Editor of *COPEIA*, and *Whereas* Mrs. Gaige and Mr. Schmidt have served this society faithfully and long,

*Therefore, be it resolved*: (1) that the Society regretfully accept these resignations and (2) that the members of the Society express their sincere appreciation to Mrs. Gaige and Mr. Schmidt for their splendid services to the Society.

*Whereas*, MR. ARTHUR W. HENN has in the past served the American Society of Ichthyologists and Herpetologists as Treasurer for a long period, and *Whereas* Mr. Henn has recently had the Society incorporated in Washington, D.C.:

*Therefore, be it resolved*: that the members of the Society express their appreciation to Mr. Henn for his many services to the Society.

*Whereas*, the proposed construction of a tramway to the summit of Mount San Jacinto in southern California would irreparably harm the San Jacinto Wilderness Area, and *Whereas*, the proposed flooding of the lower end of Grand Canyon National Park by the construction of a dam above Lake Mead would not only destroy the esthetic values of the scenery of this region but would also curtail and exterminate the fauna and flora:

*Therefore, be it resolved*: that the American Society of Ichthyologists and Herpetologists strongly oppose the invasion of these wilderness areas and that the Conservation Vice-President prepare a statement to this effect and transmit it to the proper authorities.

A total of 69 members registered and paid the \$1.00 fee assessed to cover local expenses.—EDWARD C. RANEY, *Secretary*.

News  
Notes

**D**R. CARL L. HUBBS reports word from DR. J. D. F. HARDENBERG that the institution under his direction, hitherto called "Laboratorium voor het Onderzoek der Zee, Pasar Ikan, Batavia," has now, on account of the change of government, become Laboratorium Penjelidikan Laut, Pasar Ikan, Djakarta, U.S.I. The English translation remains, as before, Laboratory for Investigation of the Sea. American ichthyologists and fisheries workers are happy to hear that the work of the Laboratory is being continued.

HENRY KRITZLER has resigned from Marine Studios, Inc., St. Augustine, Fla., to become a resident investigator at Duke University Marine Laboratory at Beaufort, N. C.

DR. LEONARD P. SCHULTZ, Curator of Fishes, U.S. National Museum, is spending July and August studying Marshall Island fishes with DR. ARTHUR D. WELANDER at the Applied Fisheries Laboratory, School of Fisheries, University of Washington, Seattle. They are using the Bikini manuscript, prepared at the National Museum during the past four years, for identifying the fishes. A few interesting species have been found and added to this manuscript, now about three-fourths completed. It is estimated that two more years will be required to finish the rather extensive report on the fishes from the Atom Bomb Tests.

The U. S. PUBLIC HEALTH SERVICE has awarded a \$7,720 research grant to the DEPARTMENT OF ICHTHYOLOGY AND HERPETOLOGY of the SCHOOL OF TROPICAL AND PREVENTIVE MEDICINE, of Loma Linda, Calif., for the investigation of poisonous and venomous fishes of the Central and South Pacific Ocean. DR. BRUCE HALSTEAD, medical zoologist of the school of tropical medicine, was named principal investigator. The investigation is to provide: 1, positive identification of poisonous fishes; 2, an accurate survey of their distribution; 3, identification of specific poisons; and 4, development of a relatively simple field test for this poison in the fishes when captured.

Word has just been received of the death of two of our Honorary Foreign Members: COLONEL FRANK WALL, of England, who died on May 19, and MONSIEUR FERNAND ANGEL, of France, who died on July 13.

# COPEIA IS THE JOURNAL OF THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

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